ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLV. No. 26. NEW YORK, SATURDAY, DECEMBER 24, 1904. ISSUED WEEKLY

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PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . LUCIEN W. MARSHALL, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada	$3.00
One Year, Foreign Countries	5.00
Single Copies, each	.10
Copies supplied for only one year back, each	.25

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ELECTRIC DECORATION.

In spite of the frequent regrettable accidents—sometimes ending fatally—following the use of candles for decorative purposes at this time of the year, this old, dangerous method is still employed because of its beautiful effects and the pleasure afforded the children. Now there are inexpensive electrical decorations which may be operated from batteries where other electrical supplies are not available, and there is small excuse for any one permitting candles to be used again. One of the saddest features of many of these accidents is that the ones who suffer are most frequently the children. All such danger may be avoided at a slight expense by using the miniature incandescent lamp. Indeed much more beautiful results may be secured in this way, because different color effects are obtainable. This is a feature which will be fully appreciated by the children, so that by using the safe method, one will be removing the danger and improving the decorations at the same time.

TELEPHONE SERVICE.

The distinct and accurate analogy between the product of a telephone exchange and that of a factory making a commodity, as pointed out in the article by Mr. McMeen in last week's issue, bears the test of mental analysis. The last decade has produced little change in telephone apparatus strictly deserving the use of the adjective. Transmitters are no more powerful and receivers no more sensitive, but a great change has been accomplished in that branch of actual telephone working sometimes denominated "traffic." This is the result of a greatly augmented number of subscribers' stations and the adoption of relay switchboards with all their advantages of rapid and accurate systems of automatic signals. There seems to be no reason for expecting that the present rate of development will soon die away or that we have reached anything like the final method of meeting the requirements of this increasing traffic. Surely it is high time that every element of the product of the telephone traffic mill should be discovered, classified and thought about, the knowledge from such effort being applied to the joint use and benefit of the service maker and the service consumer.

Among the independent companies in particular, probably on account of their later advent in the field, too little has been known even by the managers as to the real quality of the service they are giving. The management has depended largely on the reports of the subscribers, and while it may seem strange, yet it is true, that the subscribers are not as capable of judging the quality of service they are receiving as are the officials of the telephone company themselves. Service tests made by the employés of the company under proper supervision afford the best means of analyzing the service, and it is by a comparison of such analysis between various companies giving the same kinds of service that a proper conclusion on the part of operating companies may be reached.

The manufacturer and designer of telephone apparatus and equipment have done much; the true student of traffic has also accomplished much, but there are too few of the latter. What good telephone service depends on, how to find out about the service, and what to do when found out, are questions that the manufacturers of telephone service can not well spend too much time in answering.

A HYDRODYNAMIC MODEL OF ELECTRIC FLUX.

At a meeting of the Institution of Electrical Engineers, of Great Britain, in the latter part of November, a paper of exceptional interest was presented by Dr. H. S. Hele-Shaw, Dr. Alfred Hay and Mr. P. H. Powell, which describes recent investigations of the magnetic flux distribution in toothed-core armatures. The first part of this paper describes a beautiful method of representing optically the magnetic lines of force, a conception due to Faraday who, in his magnetic researches, found, as is generally the case, some physical idea of invisible conditions necessary for a clear understanding of these conditions.

The method of representing magnetic conditions described is not entirely new, since it was explained by two of the authors of the present paper some years ago. In the particular application made of it here it is a valuable aid as well to the student of science as to the designer of electrical machinery. This paper appears on another page of the present issue.

In discussing this paper there are many points which might be dwelt upon. One of the first of which impresses the reader is the practical value to the designer of electrical machinery of a method of investigation carried out, not only by the use of materials entirely different from those which enter into dynamo construction, but which represents a condition that does not exist in the machine itself. Before directing attention to these features of the method it will be necessary to say a few words about the method itself.

It was sought to obtain a model of a magnetic field. Now, the laws governing what we are accustomed to call the flow of magnetic force are the same as those which apply to the flow of a perfect fluid. If, therefore, a perfect fluid were obtainable and it be made to flow under the conditions which obtain in a magnetic field, and if the stream-lines of this fluid could be made visible a method of constructing such a model would be available. There is, however, no perfect fluid, and this would have presented a serious, if not insurmountable, obstacle to the use of a fluid model had it not been shown by Stokes that when a viscous fluid flows in a thin layer between parallel bounding planes it obeys the laws of a perfect fluid. A suitable material for making a model was thus offered. It remained to make visible the streams of flow and to construct a path offering different resistances to the flow. The first is done by injecting into the fluid used—which, in this case, was glycerine—streams of glycerine suitably dyed. This method has been used before in studying the flow of gases. To construct a path offering a different resistance at different points to the flow of the fluid it is sufficient to vary the thickness of the stream or the fluid itself, theory showing that the ratio of the cubes of the thicknesses of the layers of liquid gives the ratio of the permeabilities in the corresponding magnetic problem. The model constructed consisted, in the present case, of two plates of thick glass, upon one of which a layer of paraffine had been placed. This paraffine was then scraped away, leaving a channel which corresponded to the path along which the magnetic lines would be forced to flow, the depth of this channel corresponding, as stated, to the different permeabilities of the magnetic coils. This model was then covered with the second plate of glass, and a current of glycerine under a sufficient head was forced to pass through the passage. At a convenient point the jets of colored glycerine were introduced, and the paths traced by these colored streams correspond to the lines of force—or rather, we should say, the tubes of force—of the corresponding magnetic problem.

A number of these slides have been prepared by the authors of the paper, and the results photographed and the model itself was exhibited. The slides represent different lengths of air-gap and different shapes of tooth and slot. The streams of flow were found very similar to those which have been plotted out from theoretical considerations; but, nevertheless, the result is very striking and is far more satisfactory than any drawing could be.

But still more striking is the use which is made of these models, for by counting the number of stream-lines which enter the top of the tooth and the number which enter the tooth at the side from the slot, the correction coefficient for fringing is obtained. The actual coefficients secured in this way were found to be practically the same as those which have been obtained by considering the problem analytically. This agreement is ample justification of the use of the method in attacking such problems for obtaining constants to be used in the design of electrical machines.

The interest in this method of investigating from the designer's standpoint is the comparative ease with which the effect of varying the shape of the tooth, the dimensions of the slot, or the depth of the air-gap may be studied; but from the physical point of view the interest lies chiefly in the fact that we have used a method of studying conditions which represents what are mere conventions, and which do not actually exist. We are accustomed to speak of lines of force as though they really existed. If we care to be more exact we explain that we do not really mean lines, but tubes of force, following Faraday. However, these lines of force in our glycerine model grow from the end, while our hypothetical lines of force spring out sidewise. This, of course, in no way affects the value of the model, since, if we desire, the artificial lines could be caused to grow sidewise. But actually there are no such lines, nor, in fact, is there any flow of force. There is nothing but a strain in the medium, the distribution of which follows laws similar to those which govern the flow of a perfect fluid. That one can first adopt a certain convention to make physical conditions seem more real, and then make a model which does not even represent these conventions, but something different, and yet get accurate and useful results, is certainly most striking.

It should, perhaps, be mentioned that while this model is exceedingly useful it is not of general application, since the layer of liquid must be thin. However, permeabilities as high as 1,000 were satisfactorily represented by means of it. It would be interesting to study the design of electromagnets by means

of the model as, doubtless, some valuable data could be collected in this way.

There are other methods of investigating the distribution of magnetic flux, the most generally used being exploration of the magnetic field, by means of small coils and a ballistic galvanometer. This is, of course, a step-by-step or point-by-point method, since the exploring coil merely tells us the total flux through it. By rotating the plane of this coil in any one position, however, we may get an idea of the direction followed by the flux. Much time and ingenuity have been expended in studying the problems presented in dynamo design in this way, the results being of very great value, though the method itself is exceedingly laborious.

Another method—suggested, at least—is to represent the flow of magnetic force by a flow of electric current, replacing the magnetic path by an electric path, and making the resistance and shape of this path correspond to the reluctance and shape of the magnetic path. By determining the distribution of electrical potential throughout this path an idea of the distribution of magnetic potential might be obtained. This method would not be difficult of application, but its use would be troublesome, and it would not give us the visual representation as the hydrodynamic method does.

MAGNETIC STORMS.

For the past half-century or more efforts have been made to connect in some way so-called magnetic storms with some solar disturbances. Success in this direction has never been marked, although there is a prevailing idea that the sun really causes these storms. The latest attempt to establish a relation of this kind was made by Mr. E. W. Maunder at a recent meeting of the British Astronomical Association.

It was first supposed that magnetic storms were due to magnetic changes in the sun, but in 1892 Lord Kelvin said that such could not be the case. Another suggestion was that these storms might be due to streamers from the sun which impinge upon the earth. Attempts to establish some definite relation between magnetic storms and sun spots have also failed, since a magnetic storm does not always follow the appearance of a sun spot, and there may be storms without any unusual sun spots. Mr. Maunder seemed to find a general agreement between the appearance of sun spots and storms, especially when large disturbances only were considered. He then examined the Greenwich records for the past twenty years, and he found that in many cases there is apparently a period of recurrence of twenty-seven and one-third days. This is the apparent period of the sun's rotation. Out of some 276 storms, one-third of these were arranged in pairs spaced apart by a period of one rotation of the sun. About three-quarters of the storms showed a rotational period of one form or another.

The conclusions he reaches are that magnetic disturbances apparently recur with the return of certain definite meridians of the sun to the centre of the disc. He thinks that his research has established beyond question the origin of magnetic storms, and it introduces a new conception of the magnetic action of the sun, which seems to act magnetically within certain restricted areas and along narrow lines. Mr. Maunder's ideas have been received with a good deal of interest, but no one is yet prepared to criticise them.

NEW USES OF ELECTRICITY.

Almost every day reports of new applications of electricity come to hand. Some of these are very amusing, because they are quite improbable. Others are equally amusing, due to the fact that while the word "electricity" figures big in the headline, its use in the application described is merely as a source of power, and therefore bears no particular significance. A report of the latter kind describes an electric process for milking cows, which is said to be cleaner and quicker than the present method of hand-milking. Sifted to the bottom the electricity figures in this new and wonderful process only as a means of driving a pump; and, while we are not ready to admit that any other power could be applied quite as well here, we can not deny that a four-footed dog could do the work approximately as well as a three-phase motor.

Another report describes what was, in effect, an electric boot-jack. A young man thoughtlessly rested his foot on a wire fence during a thunderstorm. Lightning struck the fence and removed the shoe from his foot. From the report it does not appear that he was much damaged, but the condition of the shoe after the accident is not mentioned. While this is an adaptation of electricity which few would care for, it can not be denied that the lightning did its work, and did it quickly. To suggest the regular use of lightning in this way would be absurd, but it would be no more absurd than are some of the other suggestions which are put forward and received without question.

ELECTRIC DRIVING OF COTTON MILLS.

It is stated on good authority that there are to-day in cotton mills, in this country, electric motors aggregating 140,000 horse-power. The total power in cotton mills was something over 800,000 in 1900. These figures show that the electric motor is making good headway in factory driving. An objection which is frequently raised against the electric motor for driving machinery is that, as regards the cost of driving, it can not compete with steam. This can only be determined for each particular case. But the electric drive is not advocated merely as a means of reducing cost. Indeed, this is a minor feature, for the costs of driving the machinery is not, by any means, the total cost of operating the plant. The main advantage of the electric drive is the increase in output which it makes possible, and the better character of the work which may be done on electrically driven machines. When these features are borne in mind with the other advantages, such as saving in space, the elimination of belts and increased safety for the operators, a small change one way or the other in the cost of driving the machines becomes insignificant.

GROUNDED TRANSMISSION MEDIUMS—V.

BY J. STANLEY RICHMOND.

VOLTAGE CONTOUR LINES.

A somewhat interesting phase, though, in the main, only a scientific one, of grounded track return investigations is the plotting of voltage contour lines. While these lines can not be plotted absolutely correctly without data obtained by means so expensive as to be practically prohibitive, fairly accurate information can be secured by the use of apparatus which can be mounted and carried on a light emergency wagon.

A somewhat detailed description of the apparatus and methods to be adopted in order to carry out this work can be given under three headings: apparatus, survey, and map-work; all the details of which should be under the personal supervision of one man, an expert. The major portion of the necessary apparatus can be designed in the draughting room and built in the car shops of the average street railway company. The surveys can be made by students of some technical college during their summer vacation at a small remuneration. For the information which they obtain of practical scientific electrical conditions, traction plant and street railway operation is very valuable to them; inasmuch as it gives them a renewed inclination for their remaining college work and a preliminary training for some of the duties which will have to be subsequently undertaken by them. The difficult portion of the map-work can be undertaken only by the expert. This consists of reducing the mass of data turned in by the surveyors to figures entered on a rough map, which rough map is taken in hand by the draughting department, and a finished map made on tracing cloth with the required contour lines plotted on it.

APPARATUS.

The first thing that should be located, so as to prevent any loss of time when the remainder of the apparatus is ready, is some light wagon, mounted, if possible, on springs, and a one-inch board, twelve inches wide, to be fastened inside, edgewise against one of its sides. This board should be planed and long enough to reach from the front to the middle of the wagon, and is intended to serve as a table for the required instrument, some of the wiring and as a rough desk for the student in charge of the survey. The top of this improvised table should be about one inch below the top of the wagon side. The horse should be of a fairly heavy build, and not of a nervous temperament. The required instrument is a below-and-above-zero reading duplex potential-meter (Richmond pattern, made by the Weston Electrical Instrument Company). As drops have to be taken between points situated as much as 1,200 feet apart, it is necessary to have some means whereby about 1,300 feet of flexible twin-conductor electric light cord can be rapidly run out and hauled in for this distance. To meet this requirement, the writer designed a self-winding reel, which, in the main, consists of three compartments formed by means of four triangular cast-iron plates. Fig. 21 is a diagrammatic representation of this machine.

The compartment formed by the first and second plates contains a light wooden drum, the diameter of the core being about one-half that of the flanges, a projection on the outside one of which flanges is encircled by two insulated brass rings making contact with two end-on brushes held by brush-holders attached to but insulated from the inside face of the first plate. The axle, on which this drum is mounted, is located near the apex of the machine, revolves between the first and the third plates on headless, pointed set-screws, which set-screws are provided with lock-nuts to keep them firmly fixed after they are adjusted, and on it, between the second and third plates, is keyed the lighter of the two pinions of the double reduction gearing.

Near the bottom of the machine, between the second and fourth plates and running clear of the third plate, is located another axle on similar set-screws. On this axle, between the third and fourth plates, are anchored the inner-looped ends of three spiral springs, each made of one-eighth inch spring steel two inches wide and forty feet long. The outer looped-ends of these springs are slipped over the bushing of one of the double-ended tie-bolts which hold the plates in position. On the same axle, between the second and third plates, is keyed the heavier of the two gears of the double-reduction gearing.

About midway between the spring and the drum axles is located the intermediate axle on similar pointed set-screws, between the second and third plates. On this axle is keyed the heavier of the two pinions of the gearing, so placed that its teeth are geared into the teeth of the spring axle gear; and on it is also keyed the lighter of the two gears, so placed that its teeth are geared into the teeth of the drum-axle pinion.

The second and third compartments are covered over with one piece of sheet iron, bent to fit and fastened to the plates by means of 14/20 (or 1/4 standard) round-head machine screws. In the centre of the cover, for nearly its full width, is cut out about a six-inch portion, over which is fitted a sliding cover, so that the bearings of the axles on the pointed set-screws can be reached from time to time for oiling purposes.

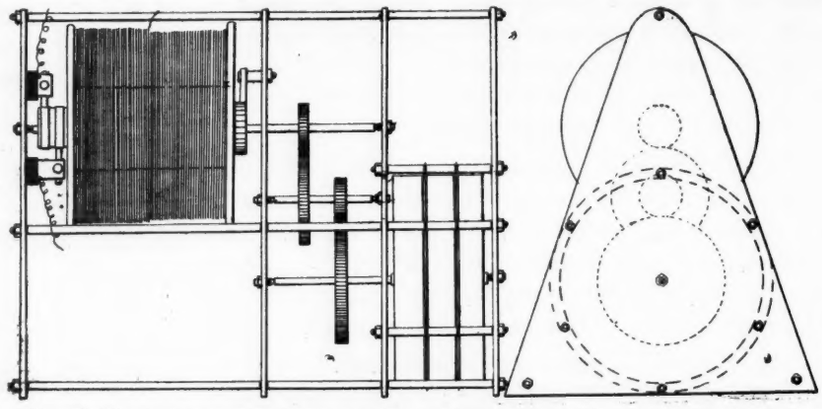


FIG. 21.—DIAGRAMMATIC REPRESENTATION OF APPARATUS FOR USE IN SECURING DATA FOR PLOTTING VOLTAGE CONTOUR LINES.

The plates are fastened together by means of double-ended tie-bolts with two nuts at each end (one nut inside and the other one outside of each plate). The spacing between the plates is obtained by means of bushings made out of iron pipe and slipped over the tie-bolts. On the outside of each plate is attached a strong handle, the two points of each plate to which such are attached being strengthened by means of bosses cast on them.

A few points to assist in the construction of one of the machines are as follows: the pattern for the plates should be made in the form of a skeleton frame, to allow for the necessary requirements of the various tie-bolts and set-screws, which frame should then be glued and screwed to a thin board. When the pieces are firmly set, the portions of the board pro-

truding beyond the frame should be sawed off and the pattern, after receiving the necessary draught, be finished in the usual way with black shellac. As only two of the plates require bosses, the pattern portions for these can be made detachable.

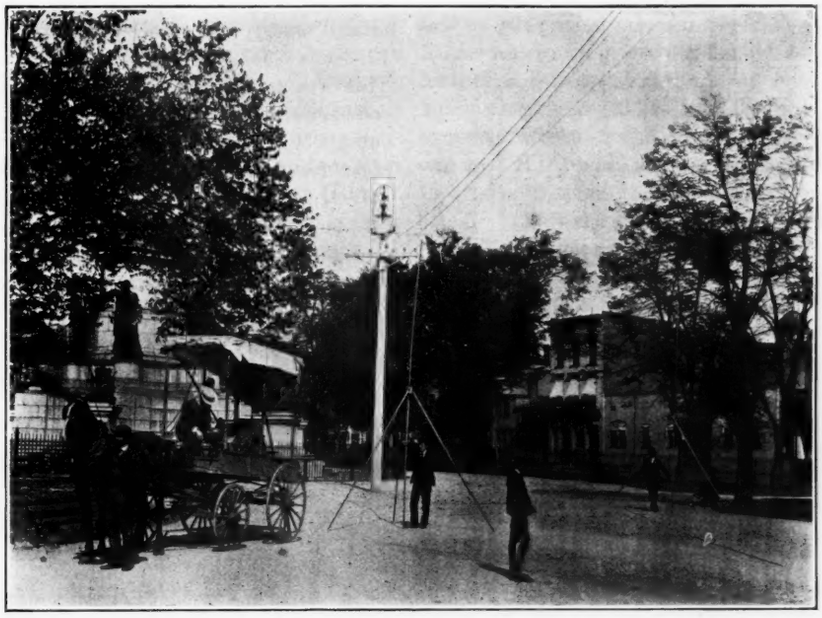


Fig. 22 —The Use of Tripod and Pole for Spanning Street Crossings

For drilling, one of the plates should be laid off and centered, the four plates be clamped together and the holes required similarly in the four be drilled simultaneously, care being taken that the size of the hole drilled at any particular point is not larger than the smallest one required by any one of the four (any hole in any one of the plates which is smaller than necessary can be bored out afterward to the size required). Those holes which are not required at similar points in all the plates can be drilled afterward by clamping only two or three of the plates together. The opposite holes in any two plates to be threaded for two set-screws should have the taps run through them simultaneously while the plates are bolted together, so that the screws which act as bearings may have their centres true. The three springs should be separated by two discs of thin sheet iron, the centre holes of which disc should clear the spring axle and those around the circumferences clear the tie-bolts but not the bushings. The drum should first be turned in the rough on its axle, the circular rings be then driven on and the whole be finally finished in the lathe, including the oiling and shellacing. When the machine is ready for the electric light cord, which should have a thin inner insulation of rubber, a strap can be used between one of the lathe pulleys and the drum to wind the springs up. When so wound up, one end of the cord can be pushed through a hole in the flange and the two conductors be connected to the two circular rings. The drum can then be allowed to unwind and thereby wind up the cord. Attached to the side of the drum, opposite to the side having the rings, is a ratchet wheel to be used in conjunction with a pawl pivoted on the second plate. This is to check the reel from rewinding when unwound.

To assist the surveyor to stretch his wire and keep it high enough for vehicles to pass under, and also to keep it above the trolley wires of cross-lines, it is necessary to have some light portable poles. Some idea of the way these poles are constructed and used will be gained from an examination of Fig. 22, which is a reproduction of a photograph of the wagon when in service.

These poles, in the main, consist of a tripod supporting the pole proper, which is in the centre and made of two poles about one and one-half inches in diameter jointed together by means of a piece of iron pipe about fourteen inches long and firmly fixed in a circular block of wood. The bottom pole, which is about twelve feet long, is permanently fastened in the pipe, while the top one, which is about fourteen feet long, has its bottom end so turned that it can be easily taken in and out of the pipe (ferrule). Near the top end of the pole is screwed a strong iron screw-hook for the wire to slip in and out of. The tripod portion of three similar poles about fourteen feet long is hinged to the circular block by means of strong iron screw-eyes. The bottom ends

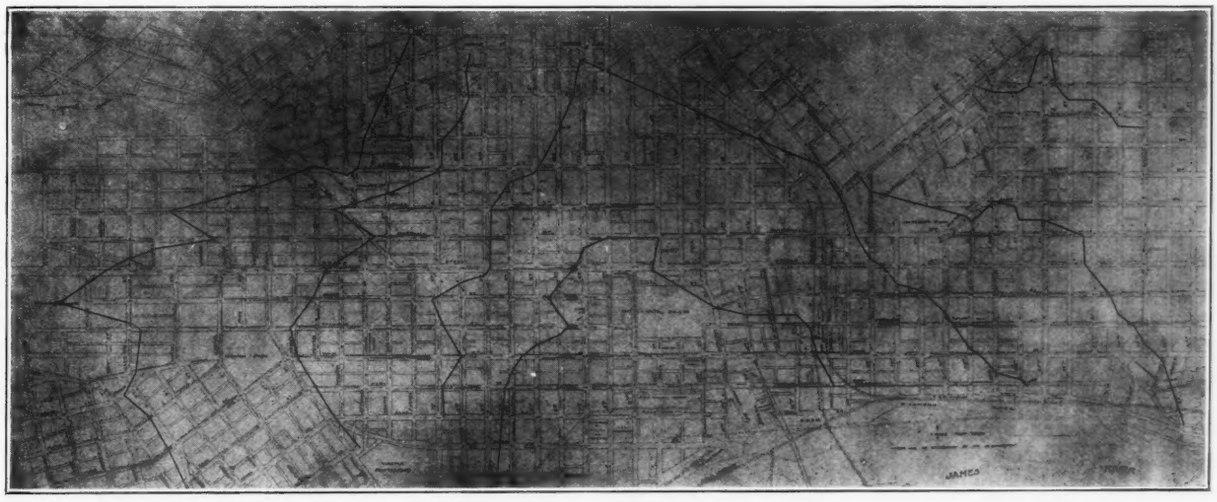


Fig. 23.—Reproduction of Map with Voltage Contour Lines Plotted.

of the pole and the three legs of the tripod are provided with spikes. These are made by screwing in strong iron wood-screws for about half their length and then grinding the projecting portions to a point on an emery wheel.

To use the testing wagon, which is provided with a canvas covering stretched on a light framework, the reel is placed on the rear end and the two wires which run from the brushes are connected in multiple to one of the meter posts. To the other post of the meter is attached a short length of flexible cord with a small iron clamp connected to its outer end. A similar clamp is connected to the two ends of the two wires from the reel. This latter clamp is then attached to a hydrant and the driver ordered to go ahead. As the wire unwinds, it is hooked up on such convenient places as lampposts, pole-steps and branches of trees. At cross streets, the portable poles are used. When the next hydrant is reached, the other clamp is attached to it and a reading taken. This clamp is then loosened and the wagon proceeds to the next hydrant, where the clamp is again used and another reading is taken. This is repeated until all the wire is unwound and the last reading for this stretch is taken. The wire is then loosened from the first hydrant and allowed to rewind. If the weight of the wire or its resistance is sufficient to check the winding, such is easily assisted by one of the attendants.

After readings have been taken on all the streets running in one direction, similar ones are taken on those running at right angles to the first ones.

When all the readings have been taken, the expert works out from them the relative voltages of the different points as compared with a chosen zero, and the drawing office is supplied with them in order to plot the contour lines.

Fig. 23 is a reproduction of a map with contour lines so gotten up, and shows from an electrolytic point of view a condition very favorable to the traction interests of the neighborhood.

Sir Oliver Lodge on Lightning Conductors.

A lecture on lightning conductors was delivered recently by Sir Oliver Lodge, at a meeting of the Birmingham Agricultural Association. An abstract of this lecture is given in the *Mechanical Engineer* (London), November 26.

The lecturer said that when his attention was drawn to lightning arresters in 1887 he found that the subject had not been approached in the light of new theories and new knowledge of electricity; that the conductors were not advanced much beyond the times of Benjamin Franklin. The old view of lightning protection was as if it were something to be let down like rain, or as if there were a certain amount of stuff to get rid of, which would take an easier path, so that if a channel were provided for it, it would go down that channel and avoid all others, and that the easier path would protect others. The existence of electrical inertia was not recognized. It was also supposed that the best way to get rid of the electricity one did not want was to supply it to the best possible conductor—the largest and best conductor one could afford—and the only reason for not using a copper rod a foot thick was that it was too expensive. But a copper rod a foot thick would be dangerous. An iron rod one-tenth of an inch thick would be much safer. Conditions had reached such a stage that lightning arresters were being considered dangerous. The lecturer did not advocate the abolition of lightning arresters. It was desirable to have them, but there were certain things to be considered about them before they became as safe as they could be. He thought that very few lightning conductors could be considered absolutely safe. If one wanted to be protected properly, many conductors were better than one, and an iron conductor was better than copper. A small iron wire was ample protection so long as the wire lasted. It is true that lightning might dissipate the wire, but by that time the flash was over, the conductor had served its purpose. It was better to have a number of cheap conductors than one or two expensive ones. If one wanted to be absolutely immune from lightning, such protection could be provided by a complete metallic enclosure. However much this might be struck, the inside would not be affected.

Electric Suburban Railways in Malaga.

It is reported by United States Consul D. R. Birch, at Malaga, Spain, that the project of constructing an electric suburban railway at Malaga will probably be carried out in the near future. It is expected that the work will begin on this road before the end of the year. The chief function of the line will be the conveying of large quantities of sugar cane, olives and olive oil, almonds and raisins which are now brought into Malaga on mule-back. A passenger service will also be established, but this will be subordinate to the freight. There is in contemplation, also, a second line to Coin, a small town thirty miles southwest of Malaga. Although the concession for the former road mentions steam as the power to be used, it is thought that electricity will be adopted.

Production of Gas, Coke, Tar and Ammonia in 1903.

The United States Geological Survey, in press bulletin No. 156, states that in 1903, 7.4 per cent of the total coke product of the United States was manufactured in by-product coke ovens. The total quantity of coal carbonized in 1903 was 5,843,538 tons of 2,000 pounds. This was accomplished by 528 different companies, which produced 33,483,430,989 cubic feet of gas, of which 2,433,969,478 cubic feet were lost or unaccounted for, and 31,049,461,511 cubic feet were sold. Of the latter figure, 73.9 per cent was sold for illuminating purposes, and 26.1 per cent for fuel. The average price per 1,000 cubic feet for all gas sold in 1903 was ninety-seven cents. Prices for artificial gas were low in the states of Illinois, Indiana, Kentucky, Ohio, Pennsylvania and West Virginia, which have natural gas and coal among their resources, and also in Massachusetts, where a large portion of the coal gas is made a by-product from coke made in retort ovens. The total production of coke amounted to 3,941,282 tons of 2,000 tons. Of this 1,882,394 tons were obtained from by-product coke ovens, and 2,058,888 tons were the product of gas houses. A large number of coke companies engaged also in the electric light business, and used the coke, and also some tar produced at the gasworks, for firing the electric light plants. Some coal gas producers are also producers of water gas, and used the coke from the coal benches for firing the water gas plants. Other gasworks used some coke in the carbonization of coal.

The total quantity of coal-tar produced in 1903 was 62,964,393 gallons. Its value was $2,199,969, or 3.49 cents a gallon. The largest producer of tar in 1902 and 1903 was Massachusetts. New York was second; Ohio, third; Pennsylvania, fourth, and Alabama, fifth.

Twenty per cent of the companies questioned reported the recovery of ammonia. The total quantity of ammonia liquor produced and sold was 64,396,662 gallons, which is equivalent to 17,479,759 pounds of anhydrous ammonia, or 67,821,465 pounds of ammonia sulphate. The total quantity of ammonia sulphate produced and sold in 1903 was 11,925,752 pounds. The equivalent production of sulphate in 1903 was 79,747,217 pounds.

Comparatively little progress has been made in the United States in the manufacture of chemical products from coal-tar. A conservative estimate of the value of such products in this country is $12,000,000.

An Up-to-Date English Steam Turbine Electric Power Station.

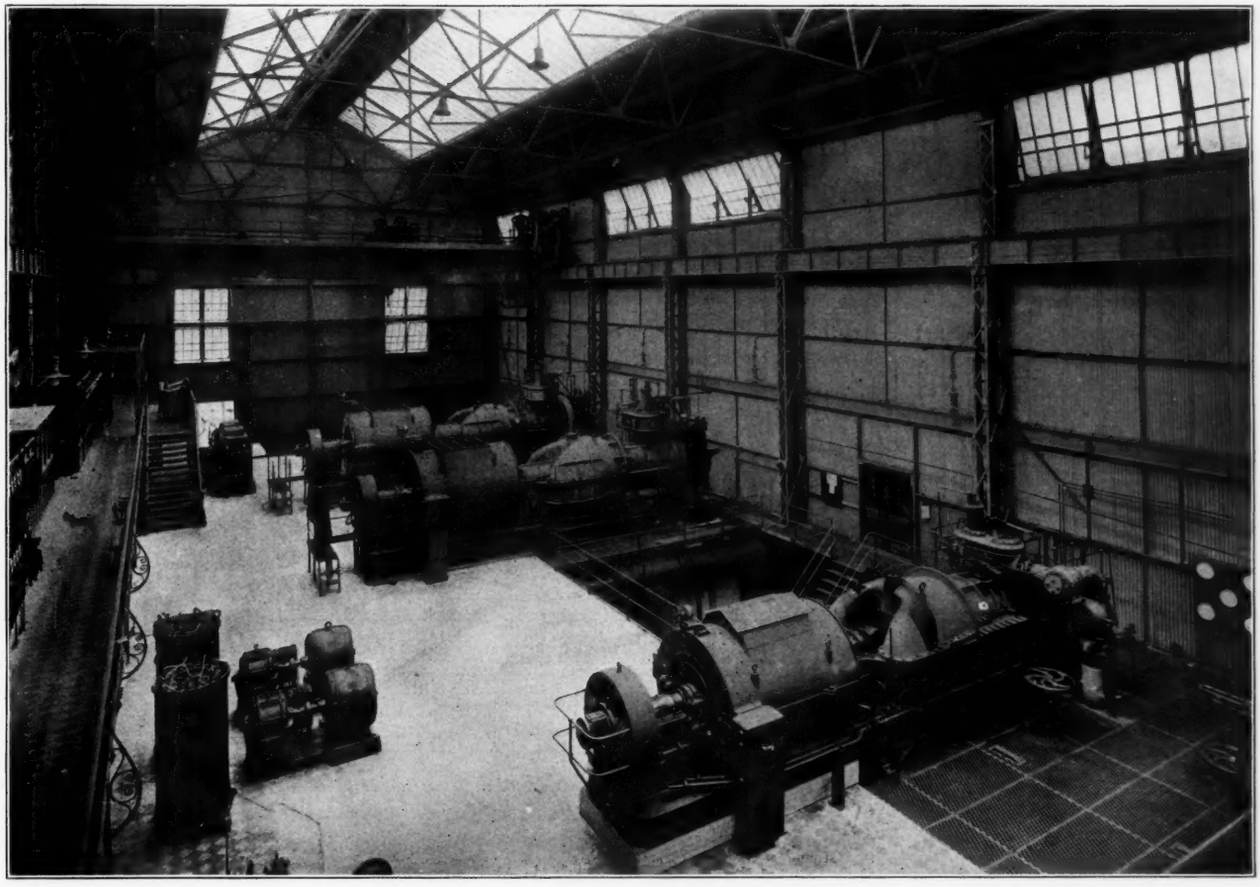
By Frank C. Perkins.

I—BOILER AND ENGINE-ROOM EQUIPMENT.

THE accompanying illustrations show the interior of a modern power station and substation supplying current for operating electric trains on the Northeastern Railway, of England. The credit for this design of steam turbine power plant belongs to Mr. Charles H. Merz, consulting engineer for the Newcastle Electric Supply Company, Limited, and the railway above mentioned. In the designing of this power station careful consideration was given to various prime movers, including the high-power gas engine, the reciprocating steam engine and the modern steam turbine. The steam turbine was chosen on account of its advantages of small space required, low oil cost, capital, repair and labor costs. The Carville power station is so arranged that the boiler house lies at right angles to the engine room so as to avoid long lengths of steam piping, each battery of boilers feeding the generating set which is located opposite it in the turbine room. Each turbo-alternator works independently, the station being in reality divided into separate sections. A separate chimney is used for each complete boiler house and each feed pump is sufficient for five boilers.

One boiler in each section is held in reserve, four being sufficient for supplying steam for a single generating unit. The engine room is at present equipped with two 2,000-kilowatt turbo-alternators and two turbo-generators of 5,000 kilowatts each, making the total output of the Carville station 14,000 kilowatts. It is stated that the steam consumption for these turbines, which are of the Parsons type, is somewhat less than sixteen pounds per kilowatt-hour for the large units, and eighteen pounds per kilowatt-hour for the smaller sets. Forced lubrication is provided for the bearings, and mechanical governors are used which allow the normal speed which is 1,200 revolutions per minute to be varied by five per cent at any load up to the total output.

Electric controlling apparatus is provided at the switchboard for the adjustment of the governor, and this may also be done at the turbine by hand. Between no load and full normal load these turbines do not vary in speed more than three per cent, and between maximum load and no load the variation is less than five per cent. It is stated that mechanical safety governors are also installed which may be operated by hand from either the basement or the main floor and which cut off the steam automatically when the speed rises to 1,400 revolutions per minute.



THE CARVILLE POWER STATION OF THE NORTHEASTERN RAILWAY, OF ENGLAND.

The turbines are directly coupled to alternating-current generators of the revolving field type, supplying a three-phase current having a frequency of forty cycles per second, and a pressure of 5,750 volts. On the end of the turbo-alternator shaft continuous-current dynamos are mounted, supplying direct current to the field-windings of the main generators without utilizing any regulating resistance. This exciter has a separately excited field and

the regulating resistances are placed in this 100-volt circuit, the current being supplied from a motor-generator or storage battery.

A vacuum augmenter has been installed under each turbine, together with the surface condenser, and a higher vacuum is thus obtained as the suspended vapor and the water from the condensed steam are taken separately from the condenser chamber.

Electric power is utilized very largely in the Carville power station for operating the auxiliary apparatus, and this method is particularly recommended by the consulting engineer, Charles H. Merz. Three-phase motors are employed for driving the air pumps which are of the Parsons three-throw type, a plunger pump being connected on the extension shaft of each pump for raising water to the hot well from the air pump discharge, which may be diverted to a weigh-bridge and tank, thus making it possible to know at any time what the steam consumption of any turbo-alternator is.

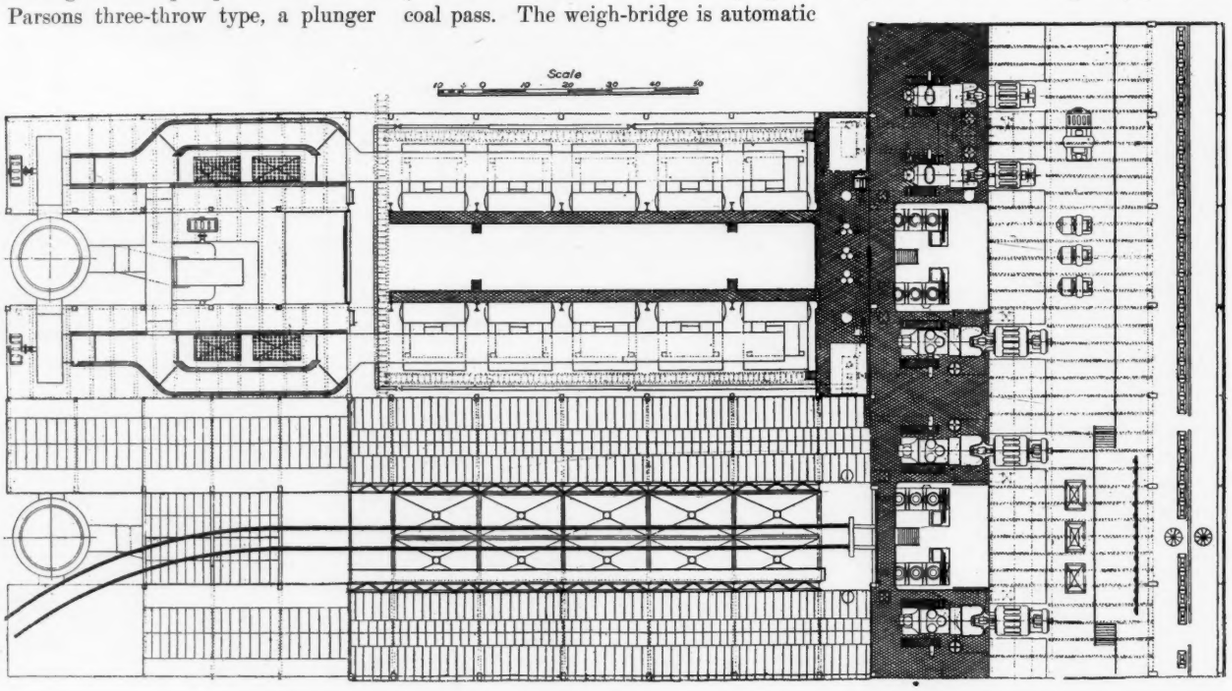
Three-phase motors are also provided in the pump house for operating two centrifugal pumps, providing circulating water for the condensers from the river Tyne. This electric pump house was installed at the riverside on a jetty, and is supplied with current by an overhead power transmission line.

The engine room is also equipped with an electrically operated Craven overhead travelling crane, having a capacity of forty tons for the main hoisting gear, and ten tons for the auxiliary lifting crab, three-phase induction motors also being utilized for this apparatus.

Among the other electrically driven, labor-saving devices used at this station should be mentioned the electric locomotive which runs on an overhead siding, the coal being discharged to the bunkers from a siding of the Northeastern Railway. The locomotive has a capacity of fifty tons at a speed of four miles per hour on a grade of one in twenty-five. It is operated by two seventy-five-horsepower Westinghouse motors of the direct-current type, the current being conducted to the locomotive by a bow collector from an overhead trolley line.

An electrically operated weigh-bridge is provided over which the cars carrying the coal pass. The weigh-bridge is automatic and is a most ingenious mechanism. The motor and steelyard are installed in a small building to which the coal cars are brought by the electric locomotives. The cars are lifted clear from the rails and placed upon knife edges by means of a steel platform which rises between the rails and comes under the flanges of the wheel. The coal car is held in position so as not to run off the platform, and the weighing is recorded automatically on a card which is placed in a slot provided for the purpose as soon as the proper lever is moved. The stops which hold the car then disappear, the platform is lowered and a signal is given which shows above the building, and everything is ready for the weighing of the next car, the latter operations being accomplished by the reversing of the motor.

A single steel-plate coal bunker is provided which is twenty-two feet wide, fourteen feet deep, and nearly 100 feet in length, with a capacity of 750 tons. It is divided by steel-plate partitions into five parts. After being weighed the coal car is drawn over the coal bunker and discharged. Cast-steel mouthpieces are arranged at the bottom of the hoppers and the coal, on passing to the stoker hoppers, is automatically weighed. An ash-pit door is provided under each boiler which discharges ashes automatically and regularly to the ash conveyer. Electrically driven scrapers are also provided for the Green economizer and electrically operated induced draught-fans have also been installed, but a natural draught by-pass is also arranged for use when the fans are not required at low load.



PLAN OF CARVILLE POWER STATION, SHOWING BOILERS AND TURBINES.

Steel girders have been placed above the boilers supporting two main flues, each of which carries off the smoke and gases from five boilers. These two main flues carry the products of combustion to a fourteen-foot steel-plate chimney which is 114 feet high. The following statements are of interest on the arrangement of the auxiliary plant, as given by Merz and McClellan in their recent paper on "Power Station Design" before the Institution of Electrical Engineers.

"The arrangement of the auxiliary plant (including in this term all piping and cable connections) is a most important factor in the design of the engine room.

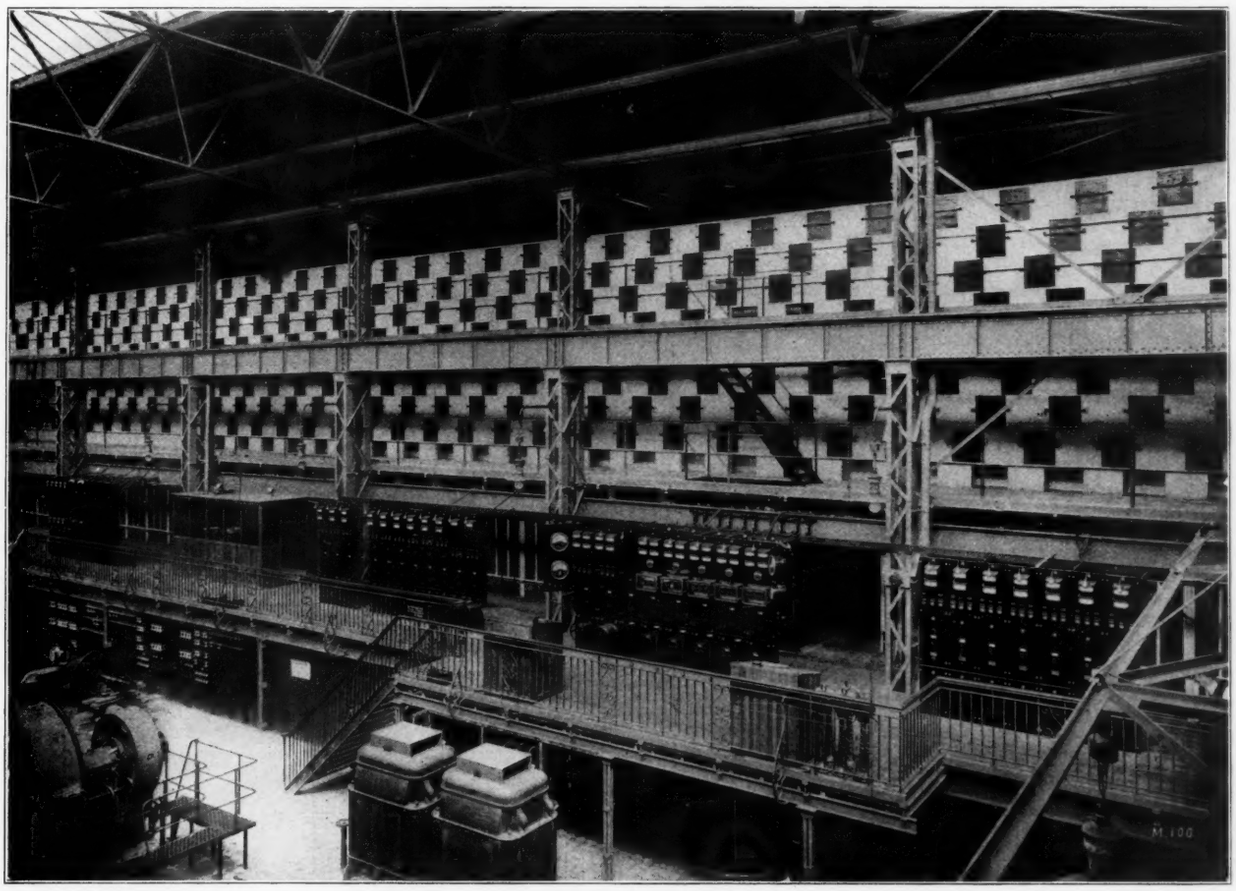
"A design which probably originated

on the Continent and which is carried out there extensively has also been largely adopted in this country, *i. e.*, the provision of a basement to contain all pipes and auxiliary machinery. Experience has shown this to be an extravagant method, affecting adversely both capital and running costs. It is, in short, directly antagonistic to the requirements which we have laid down as essential to an efficient design. It is also expensive in running wages, as unless the plant be allowed to run with practically no attention more men are required, and it is expensive in repairs on account of the difficulty of providing lifting tackle and the necessity of working entirely with localized artificial light. Against these objections the only advantage is a clean engine-room floor. Various arrangements have been adopted by engineers to avoid the inherent defect of installing the auxiliary apparatus in the basement. The provision of wells or pits instead of a basement in the main engine room has been frequently adapted and though this arrangement hardly gets over the difficulty with regard to piping, it certainly reduces the supervision and attention required.

"The turbine, on account of the small floor space which it occupies, has simplified matters immensely, as with it all apparatus can easily be put on the one floor or, as is desirable on account of increased efficiency, the condenser may be placed directly below the turbine; in the latter case the turbine, as it requires little or no attention, can be left to run by itself at a higher level with merely a gallery around it. The auxiliary apparatus, requiring as it does much more attention, can then be put on what may be regarded as the main floor. Both arrangements allow of all apparatus being conveniently handled by the main crane—though neither provides that perfect looking engine room which is a feature of many Continental stations.

"The tendency seems to be in modern central power stations to utilize electrically driven auxiliaries wherever possible instead of the steam-driven auxiliaries heretofore employed. The economy of the auxiliary plant is certainly of the greatest importance as it is certainly responsible for quite a percentage of the total coal bill of the plant." The following interesting statements by the above mentioned engineer are also of interest in reference to steam and electrically operated auxiliaries.

"After making a careful balance sheet of the respective merits of steam and electrically driven auxiliaries it will be found that it is impossible to lay down any hard and fast rule which will apply to all cases or to all classes of auxiliary machinery, partly on account of the widely different conditions under which the machinery has to operate and partly on account of the effect which the general design of the station has on this question. For instance, the American practice of omitting economizers leads to the adoption of steam-driven auxiliaries exhausting into feed-water heaters, while economizers are almost universally installed in English and Continental practice; it follows that there is less gain to be derived from exhaust steam-feed heaters. To adopt electrically driven auxiliaries either involves that the capacity of the main-generating units be increased by ten per cent, or, as an alternative, that this



CARVILLE POWER STATION OF THE NORTHEASTERN RAILWAY, OF ENGLAND, SHOWING SWITCHBOARD GALLERIES.

amount of special generating plant be installed. In either case the cost of the additional generating plant must be debited against electrical auxiliaries, as steam-driven apparatus merely requires the provision of the additional boiler capacity."

II—CARVILLE MAIN SWITCHBOARD AND SUBSTATION EQUIPMENT.

The current generated at the Carville power station has a pressure of 5,750 volts and a frequency of forty cycles per second, and after leaving the switchboard at the generating plant is conducted by three-core cables to five substations located along the Northeastern Railway. These substations supply a direct current at 600 volts to electric trains, consisting of two motor cars with a trailer between equipped with Sprague multiple-unit control.

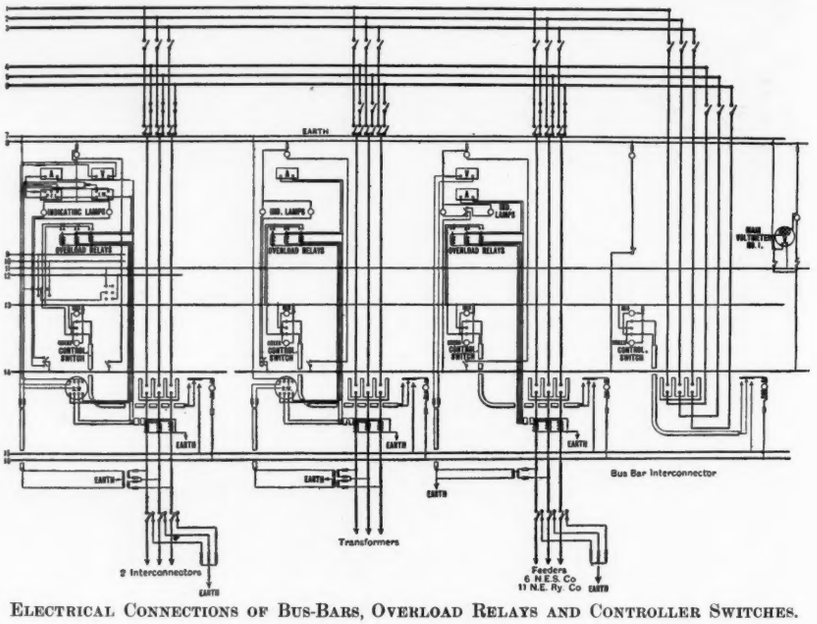
The high-tension switches of the main switchboard are of the oil type and the different phases of each circuit are separated, and the three poles are not arranged in a single oil tank as is frequently employed on three-phase circuits of 6,000 volts. At the Carville switchboard electrical control is employed throughout for both opening and closing the switches, the cutting out being automatic in action.

The main switchboard is arranged in four galleries extending along the entire length of the engine room. The lower gallery is used for the instrument transformers, while the second gallery is equipped with the operating panels and the main oil switches, the third gallery, as well as the fourth, containing the various bus-bars. The cables from the turbo-alternator sets as well as the outgoing feeders to the transmission line are all connected with their own switch gear passing directly up to the same through the ground floor. The switchboard for each turbo-generator is separate and complete, the panels for each passing directly up through the entire four galleries to the top of the station. There is no brickwork connected with this switchboard installation, the panels being constructed of concrete, as well as the chambers and partitions, which are covered with white enamel paint.

The oil switches are of the British Thomson-Houston type, the moving contacts of which are carried by three wooden rods on an iron cross-piece which is supported on a parallel link motion, giving it a vertical travel. A crank is connected to the link motion in such a manner that it is on its top dead centre when the switch is open and on its bottom dead centre when the switch is in a closed position. An electric motor operates the driving spindle through a worm-shaft and worm-wheel, a friction clutch being so arranged that the switch mechanism can not lag behind the motor, but can run faster than it is being driven, so that a quick break is obtained, the mechanism traveling very rapidly as soon as the motor has moved the crank over the dead centre, springs being provided which are compressed in the closed as well as the open position. Signal lamps and contact fingers are provided so that it may be instantly known when a switch has been closed or opened. A pair of brass oil pots are mounted on insulators for each phase, forming the main contact. When the switch is opened the main contacts are opened first and then the rods break circuit with the auxiliary contacts, and when the switch is closed the contact in air is made after the contact has been made under the oil. The cables leave the oil switches, passing up to the next gallery where one is connected to a bus-bar, the other passing up to the fourth gallery and being connected to another bus-bar on the fourth gallery, both through isolating switches.

The feeder cables outside the Carville station are laid in wooden troughs covered with three-inch tiles and filled in with pitch, while inside the station iron troughs are used instead of wood, with iron covers, a single cable being placed in each trough. The cables are of the three-core, paper-insulated copper and lead-sheath type. The cables terminate in cast-iron dividing boxes where junction is made with single-core lead cables connecting the separate phase compartments, where they are connected to isolating switches, which are particularly desirable when it is necessary to overhaul or clean the main apparatus. The series transformers for operating the ammeters and relays are above the main isolating switches, and the main oil switches are connected through the floor with the tops of the transformers.

Three black enameled slate switchboards are on the same gallery as the oil switches and form the operating board, consisting of two feeder boards for the Northeastern Railway Traction Supply and the Newcastle Light and Power Supply, together with a generator board located in the centre, with swinging panels at each end for the synchronizing lamps, voltmeters and rotating synchronizers.



ELECTRICAL CONNECTIONS OF BUS-BARS, OVERLOAD RELAYS AND CONTROLLER SWITCHES.

There are two 750-kilowatt, three-phase transformers, with star connections on the low-tension side giving 480 volts and mesh connections on the high-tension side receiving a pressure of 6,000 volts, the current from this installation being used for driving the station auxiliaries. These transformers, as noted by the diagram, are connected with the high-tension bus-bars above, and the low-tension bus-bars for station work under the operating platform running the entire length of the station. The distribution boards consist of panels two feet wide, and are arranged facing the engine room.

Altogether there are connected with this power station about a dozen substations, more than half of which are used for power and lighting supply, the remaining five being located along the

Northeastern Railway at Kenton, Wallsend, Benton, Cullercoats and Pandondene, having a total capacity of over 11,000 kilowatts. The latter substation is the largest and is equipped with four rotary converters of the Westinghouse type, each having a capacity of 800 kilowatts. The Cullercoats and Wallsend substations are similar in design, but have three rotor converters of the same capacity, while the other two substations have only two 800-kilowatt converters each. The Pandondene substation is equipped with twelve 300-kilowatt, oil-insulated, self-cooling Westinghouse step-down transformers, and one 200-kilowatt Berry transformer, reducing the current from 5,750 volts to 2,000 volts, together with an induction regulator of the Siemens-Schuckert type for the lighting supply of the railway.

The twelve main transformers first mentioned reduce the pressure from 5,750 volts to 360 volts, the frequency being forty cycles per second. In this substation there are also two 500-kilowatt motor-generators of the asynchronous type, constructed by the Allgemeine Elektricitäts Gesellschaft, together with a Crompton reversible booster, and a storage-battery installation equipped with Tudor cells having a capacity of 1,000 kilowatt-hours. The switchboard at the Pandondene substation is constructed of white Sicilian marble two inches thick and consists of nineteen panels, two being required for each converter, one for the high-tension side of the transformer and another panel for the rotary converter direct-current side. The accompanying diagram shows the electrical connection. The rotaries have an efficiency of 93.93 per cent at full load and even a higher efficiency at overload, while the efficiency at three-quarter load is 93.44 per cent, the above figures being the combined efficiencies, and include the static step-down transformers as well as the rotaries.

A Long-Distance Wireless Message.

It is reported in the London *Times* that a telegram by wireless was transmitted recently by Mr. William Marconi from the Marconi company's station at Poldhu, Cornwall, to a station belonging to the Italian government at Ancona, Italy. This route is almost entirely overland, the distance being about 1,000 miles. To reach their destination, the ether waves passed over the whole of France and a considerable part of Italy, including some of the highest mountains of the Alps.

HYDRODYNAMICAL AND ELECTROMAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.[1]

BY H. S. HELE-SHAW, ALFRED HAY AND P. H. POWELL.

INTRODUCTION.

Some four years ago two of the authors of the present paper described a hydrodynamical method of attacking two-dimensional magnetic problems. A full account of this method, including a detailed description of the apparatus used and examples of the results obtained, will be found in a Royal Society paper for 1900.[2] Here it will be convenient, for the sake of those members who do not happen to have seen an account of the method, to give a brief outline of it. The laws which govern the distribution of magnetic flux in space of two dimensions are identical with those which apply to the stream-line motion of a perfect incompressible fluid in two-dimensional space. If, therefore, we had such a fluid at our disposal, and by causing it to flow between parallel bounding walls determined the distribution of the stream-lines, this distribution would also represent that of the magnetic lines or tubes in a corresponding two-dimensional magnetic problem.

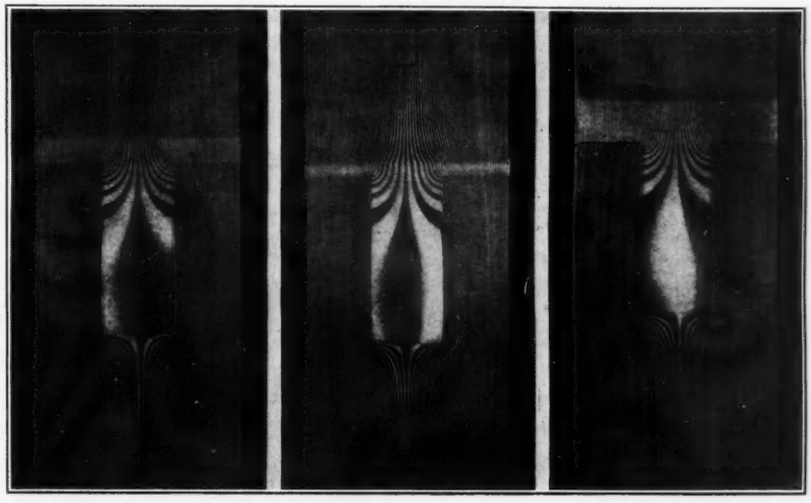


FIG. 1. FIG. 2. FIG. 3.

STREAM-LINE DIAGRAMS.

FIG. 4. FIG. 5. FIG. 6.

STREAM-LINE DIAGRAMS.

This is the underlying principle of the hydrodynamical method as applied to magnetic problems.

In trying to put the principle of this method into practice, we encounter the following difficulties: (1) the difficulty

[1] Paper read before the Institution of Electrical Engineers, of Great Britain, November 24.

[2] *Phil. Trans.*, vol. cxcv. Series A, pp. 303-327.

of mapping out the invisible stream-lines of the fluid; (2) the fact that there is no such thing as a "perfect" fluid at our disposal, every actual fluid being more or less viscous; (3) the difficulty of finding an analogue for magnetic permeability, in order to enable us to study the flux distribution in cases where the field consists of regions having different permeabilities.

The first difficulty is surmounted by using a colorless liquid into which are injected thin color bands, consisting of the same liquid mixed with a suitable dye. The second difficulty at first sight appears insurmountable. But a closer mathematical investigation by the late Sir G. G. Stokes[1] has revealed the somewhat astonishing fact that when any viscous liquid is made to flow in a very thin layer between parallel bounding walls, the stream-lines obtained are identical with those of a perfect liquid. This theoretical deduction was subsequently fully confirmed by us in the paper already referred to. The liquid used by us was glycerine, and the dye for mapping out the stream-lines was a mixture of aniline dye with permanganate of potash. The color bands were injected through a series of very minute apertures at one end of the slide between whose parallel plate-glass walls the liquid was allowed to flow. The third difficulty consists in devising a method by means of which the effects of varying magnetic permeability may be imitated. Now it may be shown, both theoretically and experimentally, that when a viscous liquid flows in a thin parallel layer, the quantity of liquid passing per second across a plane of unit length drawn normally to the stream-line is, for a given pressure gradient, proportional to the cube of the thickness of the liquid layer. Hence, if the liquid is made to flow through several regions of different thickness, the ratio of the cubes of the thicknesses gives the ratio of the permeabilities in the corresponding magnetic problem.

The practical method employed by us consisted in coating one of the thick glass plates forming the slide with a thin layer of paraffin wax, and then forming a cavity or cavities of the required shape by carefully scraping away the wax over certain areas. These areas, over which the liquid layer had a greater thickness, represented the regions of high permeability. The permeability varying in proportion to the cube of the thickness of the liquid layer, no difficulty was experienced in constructing slides in which the permeability over certain regions had as high a value as 1,000. The slide through which the liquid flowed being suitably illuminated, a photograph of it was taken, and thus a permanent record obtained of the particular stream-line distribution. The stream-line diagrams which accompany the present paper are reproductions of the photographs so obtained.

The validity of the hydrodynamical method having been established, we proceeded to apply it to some problems in dynamo design whose solution has always been a matter of considerable difficulty. In order to render the investigation more complete, however, we decided to supplement the results obtained by the hydrodynamical method by experiments carried out on an actual dynamo fitted with several armature cores having different sizes of teeth and slots, and different air-gaps. In the calculation of the magnetomotive force required to produce a given magnetic flux in a dynamo having a toothed-core armature, the designer encounters two important difficulties. The first of these is the determination of the reluctance of the air-gap, including the allowance to be made for the distortion due to the armature teeth and for the fringing effect around the edges of the pole-pieces; and the second is the determination of the reluctance of the teeth themselves. It is in connection with the first problem—that of air-gap reluctance—that the hydrodynamical method is of particular value. Although attempts were made to apply it to the second problem—that of tooth reluctance—by continuously varying the thickness of the liquid layer representing the tooth, yet the difficulties of doing this satisfactorily proved so great that the attempt had to be abandoned, and we preferred to carry out this part of the investigation electromagnetically, using the ballistic method.

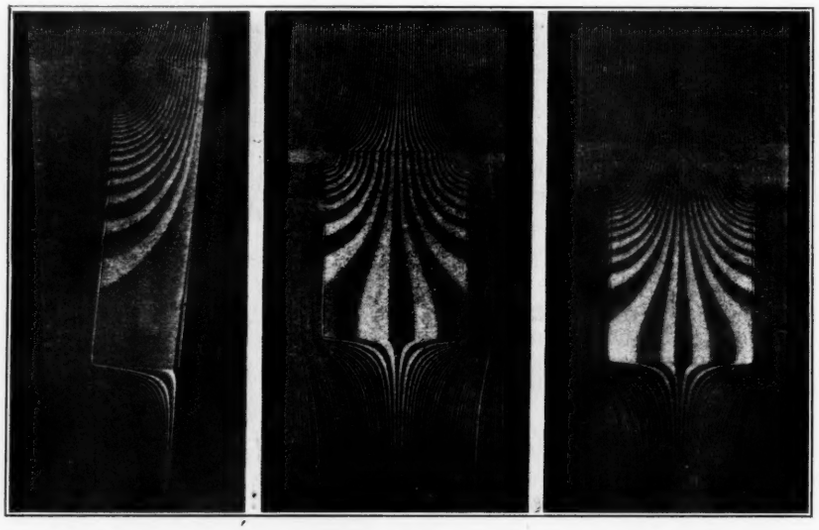


Fig. 7. Fig. 8. Fig. 9.

Stream-Line Diagrams.

HYDRODYNAMICAL INVESTIGATION OF AIR-GAP RELUCTANCE.

For the sake of completeness, and with a view to rendering the present paper as useful as possible to the dynamo designer, we propose in what follows not to restrict our attention to our own investigations, but to supplement these by an account of the more important researches carried out in this direction by other workers, and to state the results obtained in a form which will render them available for immediate practical use.

A. Fringing Problem—If we except various more or less arbitrary and imperfect empirical rules, the first attempt to deal with this problem in a scientific manner is due to Messrs. C. C. Hawkins and R. Wightman, who, in a paper entitled "The Air-Gap Induction in Continuous-Current Dynamos,"[1] obtained a correction for the fringing effect on the basis of certain very simple, though incorrect, assumptions regarding the form of the magnetic lines in the vicinity of the polar edges. Shortly afterward, Mr. F. W. Carter[2] succeeded in obtaining an exact mathematical solution of an ideal case, which, however, so closely corresponds to the actual problem that from a practical point of view the solution may be regarded as furnishing a perfect correction. The most convenient way of taking the fringing effect into account is to add to the length of the polar arc (in estimating the effective cross-sectional area of the

[1] B. A. Report, 1898.

[1] *Journal* of the Institution of Electrical Engineers, vol. xxix, p. 486.

[2] *Ibid.*, p. 925; also *Electrical World and Engineer*, of New York, vol. xxxvii, p. 884.

gap), a term consisting of the product of the single air-gap length into a certain coefficient c, whose value depends on the ratio $r = \frac{\text{distance between pole-pieces}}{\text{length of single air-gap}}$, the "distance between the pole-pieces" being measured along the armature circumference, and hence representing the length of the interpolar arc. The following table contains the values of c corresponding to various values of r:

r =	4	5	6	7	8	9	10	12	14	16	18
c =	1.32	1.59	1.79	1.89	2.15	2.30	2.43	2.65	2.84	3.00	3.15
r =	20	22	24	26	28	30	35	40	45	50	60
c =	3.28	3.40	3.51	3.61	3.70	3.78	3.98	4.14	4.28	4.40	4.66

By means of this table the necessary correction in any given case may be at once applied.

B. Problem of the Flux Distortion Brought About by Armature Teeth—It is at once obvious, without the necessity of going into any elaborate investigation, that the presence of teeth in the armature core is equivalent to an increase in the gap length (or a reduction in the gap area); for the teeth disturb the uniformity of the flux distribution, causing a crowding of the lines into the regions of the polar surface which are opposite the teeth, and thereby increasing the fall of magnetic potential, from the polar surface to the crown of any tooth, above the value which it would have if the distribution were uniform—*i. e.*, if the core were smooth—and the total flux unaltered. Assuming that the exact effect produced by the teeth is known, a convenient method of applying the necessary correction consists in multiplying the gap length by a certain "correction coefficient," and then, using this corrected value, in proceeding with the calculation as if the armature core were smooth—*i. e.*, as if the flux distribution were uniform. The "correction coefficient" clearly represents the ratio of the maximum to the mean induction. It is not difficult to see that the value of the correction coefficient depends on the two ratios s/t and s/g, where s = width of slot, t = width of tooth (at top), and g = length of gap. In Figs. 1 to 9 are given a series of stream-line diagrams for various values of the two ratios s/t and s/g, and a careful examination of these enables one to form a very good idea of the effect produced by the teeth. The chief value of the diagrams, however, lies in the fact that they enable us to determine the numerical values of the correction coefficient in the various cases. All that is necessary for this purpose is to determine the number of stream-lines per unit of length in the space well under cover of a tooth, and to divide this by the mean number of stream-lines per unit of length for tooth and slot. The values of the correction coefficient so obtained are given in table i.

Attention may be drawn to one or two features clearly exhibited by the diagrams. Two well-known effects are shown very plainly; the refraction of the lines as they pass from a medium of low into one of high permeability, and the crowding of the lines along the sharp edge of the tooth. It will be further noticed that between the straight lines in the region immediately above the tooth and the curved lines entering the slot and passing into the flank of the tooth, and exhibiting a concavity toward

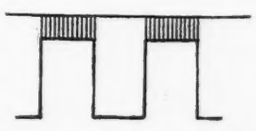


FIG. 10.—MAGNETIC FLUX DISTRIBUTION.

the tooth, there are certain intermediate or transition lines which are characterized by a point of inflection, the upper part of the line being concave and its lower part convex toward the tooth; the convexity gradually decreases as we take lines further and further away from the

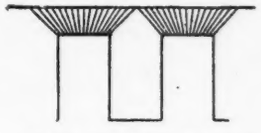


FIG. 11.—MAGNETIC FLUX DISTRIBUTION.

tooth, and is ultimately replaced by a concavity along the entire length of the line. While our experiments were in progress, a very important contribution to this subject appeared by Mr. F. W. Carter,[1] who followed up his previous success in attacking the fringing problem

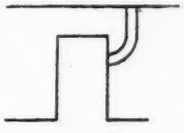


FIG. 12.—MAGNETIC FLUX DISTRIBUTION.

by working out a solution for the air-gap flux distribution in the case of a toothed-core armature, on the assumptions of negligible pole-face curvature and infinite permeability in the teeth. According to Mr. Carter, the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+(1-\sigma)\frac{s}{t}},$$

$$\text{where} \quad \sigma = \frac{2}{\pi}\left\{\tan^{-1}\frac{s}{2g} - \frac{g}{s}\log\left(1+\tfrac{1}{4}\frac{s^2}{g^2}\right)\right\}.$$

Mr. Carter's resolution furnished a correction coefficient which may be regarded as quite accurate enough for all practical purposes, and a reference to table i shows very satisfactory agreement between the values determined by our stream-line method and those calculated by means of Mr. Carter's formula. Such divergencies as exist in some cases are to be attributed to want of accuracy in working out the values from the stream-line diagrams, due to their comparatively small scale. Previous to the appearance of Mr. Carter's paper various attempts were made to deal with the problem, and it is interesting to compare the results furnished by some of these older methods with the correct values now at our disposal.

Method I—A first very rough approximation may be obtained by assuming that none of the lines pass down toward the slot, but that they all crowd into the tops of the teeth, forming a series of isolated patches, as shown in Fig. 10. The correction coefficient is on this assumption given by $\frac{t+s}{t} = 1+\frac{s}{t}$, and leads to a very considerable over-correction, which increases with increase of $\frac{s}{t}$.

Method II—It is assumed that the effective area of the air-gap is the arithmetic mean of the polar area and that corresponding to the tops of the teeth. The correction coefficient is given by

$$\frac{t+s}{t+\frac{1}{2}s} = \frac{1+\frac{s}{t}}{1+\frac{1}{2}\frac{s}{t}}$$

This method leads to an over-correction when $\frac{s}{g}$ is small, and to an under-correction when $\frac{s}{g}$ is large.

Method III—The lines are assumed to be straight, and to be distributed in wedge-shaped masses, as shown in Fig. 11. The reluctance over a width of one tooth and slot of a thin layer of unit breadth (measured in a direction parallel

[1] *Electrical World and Engineer*, of New York, vol. xxxviii, p. 884.

to the shaft), and at a distance x from the top of the tooth is $\frac{dx}{t + \frac{s}{g}x}$ where dx is the thickness of the layer. The total reluctance is thus

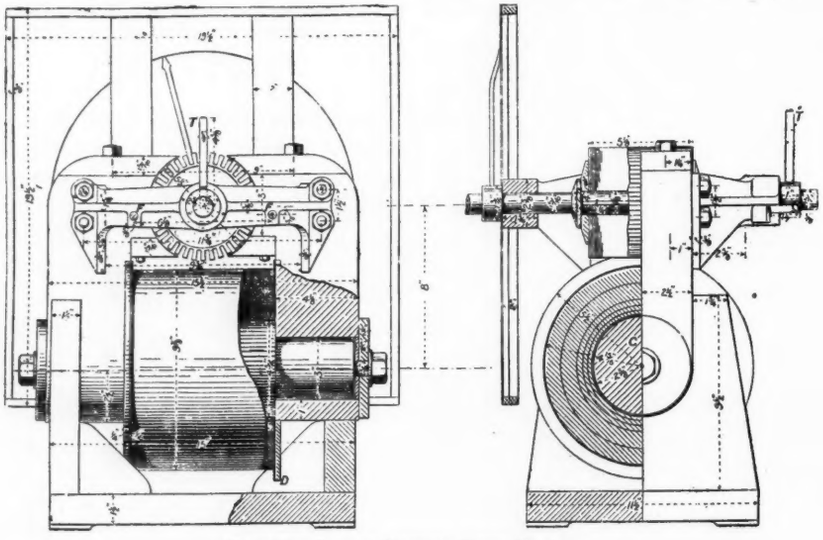


FIG. 13.—SINGLE BOBBIN TYPE DYNAMO.

$$\int_0^g \frac{dx}{t + \frac{s}{g}x} = \frac{g}{s}\log\left(1 + \frac{s}{t}\right).$$

But the reluctance corresponding to a smooth core is $\frac{g}{t+s}$. Hence the correction coefficient is $\left(1 + \frac{t}{s}\log\left(1 + \frac{s}{t}\right)\right)$

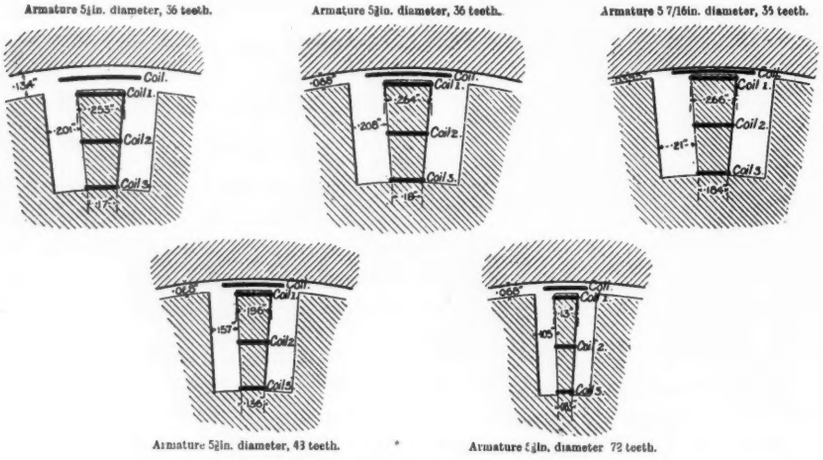

Armature 5¼in. diameter, 36 teeth.
Armature 5⅜in. diameter, 36 teeth.
Armature 5 7/16in. diameter, 36 teeth.
Armature 5⅜in. diameter, 43 teeth.
Armature 5⅜in. diameter 72 teeth.

FIG. 14.—DETAILS OF ARMATURE CORES.

This method leads to an over-correction in most cases. The three methods so far considered take no account of the ratio $\frac{s}{g}$.

Method IV—This method, due to Messrs. Hawkins and Wightman,[1] assumes that the lines which fall outside the space immediately above a tooth consist partly of straight lines and partly of quadrants of circles whose common centre is at the edge of the tooth, as shown in Fig. 12. The reluctance of the air-space above the tooth is, per unit length of tooth measured in a direction parallel to the shaft, equal to $\frac{g}{t}$, while the reluctance of an equal length of air-space above a slot is

$$\frac{1}{\int_0^{\frac{s}{2}} \frac{dx}{g + \frac{1}{2}\pi x}} = \frac{\pi}{4\log\frac{g + \frac{\pi}{4}s}{g}}$$

Hence the joint reluctance of the two air-spaces is, per unit length along shaft, given by

$$\left(\frac{\pi g}{4t\log\frac{g+\frac{\pi}{4}s}{g}}\right) \div \left(\frac{g}{t} + \frac{\pi}{4\log\frac{g+\frac{\pi}{4}s}{g}}\right)$$

$$= \frac{\pi g}{\pi t + 4g\log\frac{g+\frac{\pi}{4}s}{g}}$$

[1] *Journal* of the Institution of Electrical Engineers, vol. xxix, p. 486.

Now since the value of this reluctance for a smooth core is $\frac{g}{t+s}$, it follows that the correction coefficient is given by

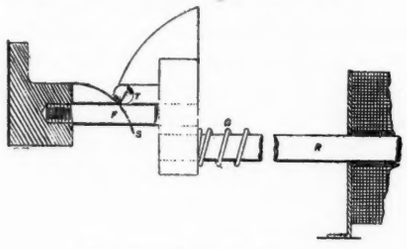


FIG. 15.—BUFFER SPRINGS.

$$\frac{1 + \frac{s}{t}}{1 + \frac{4}{\pi}\cdot\frac{g}{t}\log\left(1 + \frac{\pi}{4}\frac{s}{g}\right)}.$$

For the sake of comparison, the values

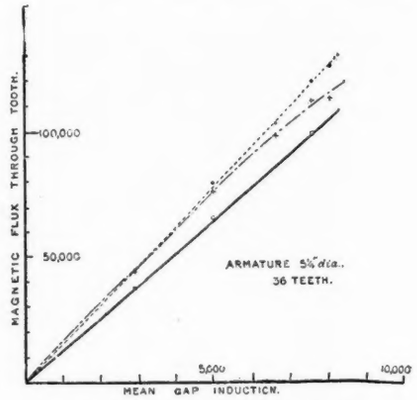


FIG. 16.—FLUX-INDUCTION CURVES.

calculated in accordance with each of these methods are included in table i, and an examination of the results shows that none of these older methods is reliable.

RELUCTANCE OF TEETH IN A SLOTTED ARMATURE.

The problem of determining the

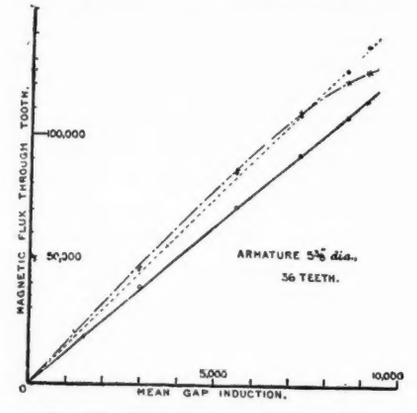


FIG. 17.—FLUX-INDUCTION CURVES.

reluctance of the teeth has generally been dealt with on the assumption that the equipotential surfaces in the teeth and slots are cylindrical surfaces coaxial with the core discs.

This assumption is far from being correct, as is at once evident by an inspection of the stream-line diagrams and an examination of the experimental results given below. Nevertheless, for practical purposes the assumption yields sufficiently accurate results. The problem is considerably more complicated in the case of armatures of small diameter, where the taper of the teeth may produce a very considerable difference between the cross-sectional areas of the top and bottom of a tooth. The most satisfactory method of dealing with the problem in such cases is that given by Mr. W. B. Hird in a paper contributed to the *Journal* of this institution.[1]

TABLE I—AIR-GAP CORRECTION COEFFICIENTS.

Figure.	$\frac{s}{t}$	$\frac{s}{g}$	Stream-line Method.	Carter's Method.	Methods. I.	Methods. II.	Methods. III.	Method IV. (Hawkins and Wightman.)
..	.500	3.42	1.18	1.16	1.50	1.20	1.22	1.21
1	.510	2.80	1.13	1.14	1.51	1.20	1.22	1.19
2	.515	6.65	1.26	1.24	1.515	1.21	1.22	1.28
..	.524	2.35	1.11	1.12	1.524	1.21	1.23	1.18
3	.530	1.68	1.10	1.09	1.53	1.21	1.23	1.14
..	.670	4.57	1.21	1.24	1.67	1.20	1.28	1.30
..	.770	2.27	1.22	1.16	1.77	1.28	1.32	1.23
..	.810	4.00	1.23	1.25	1.81	1.29	1.33	1.32
4	.940	9.60	1.52	1.48	1.94	1.32	1.37	1.53
..	.945	4.30	1.31	1 30	1.945	1.32	1.38	1.38
5	1.00	4.00	1.25	1 29	2.00	1.33	1.39	1.38
6	1.00	4.40	1.37	1.32	2.00	1.33	1.39	1.40
..	1.00	4.50	1.32	1.32	2.00	1.33	1.39	1.40
7	1.02	4 45	1.35	1.32	2.02	1.34	1.40	1.41
..	1.28	3 90	1.33	1.34	2.28	1.39	1.52	1.44
8	1.88	3 20	1.98	1.95	2.88	1.48	1.62	1.95
..	1.94	3.86	1.37	1 40	2.94	1.49	1.63	1.55
9	1.98	3.34	1.39	1.36	2.98	1.50	1 64	1.51

The object of the experiments about to be described was to investigate the exact distribution of the magnetic flux in the teeth and slots of a slotted core under varying conditions of excitation, and with varying length of gap and width of tooth.

DESCRIPTION OF APPARATUS.

The apparatus used was specially designed for the purpose, and was constructed in the workshops of the University of Liverpool. The dynamo (Fig. 13) was of the single-bobbin type, with field core and pole-pieces of Allen's dynamo steel. The pole-pieces were bored out to a diameter of five and one-half inches, and into the space between them could be introduced any one out of a set of five experimental armature cores. The cores consisted of sheet-iron stampings, supplied by Messrs. Sankey & Co., threaded on the shaft, and maintained in position by means of a feather key. The details of the five cores are given in Fig. 14, which also shows the positions of the search coils, by means of which the flux at three different cross-sections of a tooth was determined. The three cross-sections corresponded to the top, the middle, and the bottom of a tooth. In addition to the three coils surrounding the tooth, a fourth coil, of width equal to that of a tooth and slot, was used for the purpose

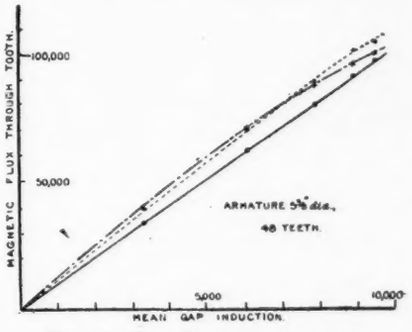


FIG. 18.—FLUX-INDUCTION CURVES.

of determining the total flux per tooth and slot, and the mean value of the gap induction. This coil was slung in position by means of silk threads suitably supported from the armature shaft, and provided with a device for adjusting the coil in the exact position required (the middle of the air-gap). Each of the three coils surrounding the tooth consisted of five turns of No. 46 wire. Considerable difficulty was experienced in insulating the coils satisfactorily, but this was successfully overcome.

In order to avoid the various difficulties and uncertainties connected with the measurement of the magnetic flux by the methods of breaking and reversing the exciting current, we decided to produce the reversal of flux by a bodily rotation of the armature with its search coils through 180 degrees. For this purpose the armature was first placed in such a position as to bring the tooth carrying the search coils opposite the middle of one of the pole-pieces. The particular search

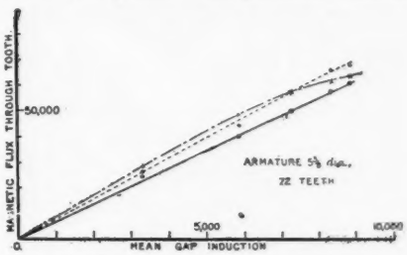


FIG. 19.—FLUX-INDUCTION CURVES.

coil in use being in connection with the ballistic galvanometer, the armature was then suddenly rotated through half a revolution, the tooth being thereby brought opposite the middle of the other pole-piece. This operation occupied an interval of time not exceeding one second. In order to limit the motion of the armature, the shaft was fitted with a striker, T (Fig. 13), capable of moving between two steel stop-pins, FF. In order to prevent excessive shock due to the sudden stoppage of the armature, buffer springs, S (Fig. 15) were provided, and in order to prevent subsequent recoil suitable catches,

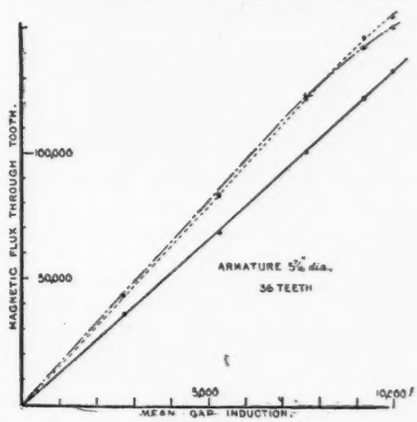


FIG. 20.—FLUX-INDUCTION CURVES.

one of which is clearly shown in Fig. 15, were fitted. Each catch is forced outward by a spring, G, which is normally in compression, and which surrounds the core, R, of a solenoid, the catch being attached to the end of the core. When the

TABLE II—DETAILS OF ARMATURE CORES AND SEARCH COILS IN GAP.

Diameter of core, in inches	$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{3}{8}$	$5\frac{3}{8}$	$5\frac{7}{16}$
Number of teeth	36	36	48	72	36
Length of single air-gap in cms.	.340	.173	.173	.173	.100
Width of slot, in cms.	.5105	.528	.399	.267	.533
Width of tooth at top, in cms.	.640	.671	.498	.330	.675
Width of tooth at middle, in cms.	.510	.528	.399	.267	.559
Width of tooth at base, in cms.	.430	.457	.345	.211	.467
Width of coil in gap, in cms.	1.165	1.15	.833	.62	1.20
Length of coil in gap, in cms.	9.70	9.68	9.5	9.39	9.49

[1] *Journal* of the Institution of Electrical Engineers, vol. xxix, p. 933.

solenoid is excited, it sucks in its core, withdrawing the catch and leaving the armature free to rotate through 180 degrees. A similar coil-and-plunger release was fitted to the catch on the other side.

In order to arrive at a correct estimate of the net cross-section of iron in the tooth, a large number of measurements were made of the thickness of the discs forming the different cores, and the number of discs in each core was carefully counted. The exact dimensions of the various exploring coils were also determined with great care. The results of the more important of these measurements are given in table ii.

The moving-coil ballistic galvanometer used in these experiments was of special construction; we found that no suitable commercial instrument could be obtained. A detailed account of the principles underlying the design of such an instrument has already been published by one of us.[1] It may, however, be mentioned that the periodic time of the instrument was about eighty seconds and that the electromagnetic damping device consisted of a copper disc suspended below the coil and acted on by a small electromagnet. Throughout the experiments the galvanometer was very frequently calibrated by means of a standard solenoid.

RESULTS OF BALLISTIC EXPERIMENTS.

The magnetic flux through the top, the middle and the bottom of the tooth was determined for five different values of the mean gap induction, ranging from about 3,000 to about 9,000 centimetre-gramme-second lines per square centimetre, for each of the five armature cores experimented upon. The results obtained are given in table iii, and are graphically exhibited in Figs. 16 to 20, the curves there shown having the mean gap induction for abscissæ and the magnetic fluxes through the various cross-sections of the tooth for ordinates. The full-line curve in each case refers to the total flux through the top of the tooth, the dotted curve to the flux through the middle of the tooth, and the chain-dotted curve to the flux through the base of the tooth. The three readings marked with an asterisk in table iii are open to some doubt, and are almost certainly too low; unfortunately, the core had been dismantled before the discrepancy was noticed, and the readings could not be repeated. A glance at the stream-line diagrams shows that the total flux through a cross-section of the tooth some distance below the surface of the armature is considerably greater than the flux through the top of the tooth. This is fully borne out by the ballistic measurements, which show clearly the steady increase in the magnetic flux as we proceed down the tooth—so long, at any rate, as the induction at the base of the tooth does not exceed about 20,000. When the induction is pushed beyond this limit, another effect, not indicated by the stream-line diagrams (in which the permeability is constant), comes into play. The flux, after reaching a maximum value at a certain depth, begins to decrease, lines of induction leaving the flank of the tooth and crowding into the slot. This effect is very strongly marked for all the higher values of the gap induction, and is indicated by the crossing of the curves in Figs. 16 to 20.

So long as the air-gap remains of constant length, and the ratio of width of slot to width of tooth is not materially altered, no appreciable change in the flux distribution along a tooth is produced by varying the number of teeth—*i. e.*, the width of tooth. If, however, the air-gap is steadily increased, then, as an examination of Figs. 16 to 20 shows, the depth at which, for a given gap induction, the flux reaches a maximum value increases with increase of air-gap.

For the range of gap induction used, the curves connecting the total flux through the top and middle cross-sections of the tooth with the mean air-gap induction are almost indistinguishable from straight lines, which necessarily pass through the origin. Such, however, is no longer the case for the curves relating to the base of the tooth, the initial portion only of which is straight. It is, of course, obvious that if it had been possible to push the induction far enough, the curves for the top and middle of the tooth would have commenced bending toward the horizontal axis in a manner similar to that of the curve for the base of the tooth—in fact, this tendency is clearly marked in the case of the dotted curves of Figs. 18 and 20.

[1] B. A. Report for 1903; or *Electrician*, vol. li, p. 1013.

TABLE III.

—	Mean Gap Induction.	Total Magnetic Flux.			Magnetic Induction.		
		Top of Tooth.	Middle of Tooth.	Base of Tooth.	Top of Tooth.	Middle of Tooth.	Base of Tooth.
Armature 5¼ in. in diameter, 36 teeth.	2,890	37 000	44,400	*43,800	4,790	7,040	8 570
	5,010	65,800	79,100	*75,900	8,520	12,600	14,850
	6,650	81,900	102,500	*97,400	10,600	16,300	19,060
	7,610	98,500	118,900	111,400	12,750	18,870	21,800
	8,110	103,200	125,000	112,300	13,370	19,850	21,980
Armature 5⅜ in. in diameter, 36 teeth.	2,950	38,900	45,200	46 300	5,070	7,120	8,920
	5,540	71,200	84,600	86,000	9,280	13,400	16,600
	7,240	92,200	108,500	109,400	12.250	17,100	20,940
	8,550	107,800	126,400	121,800	14,060	19,900	23,500
	9,120	113,800	136,200	126,000	14,800	21,500	24,300
Armature 5⅜ in. in diameter, 48 teeth.	3,290	33,200	35,100	39,600	5,350	7,440	8,700
	6,020	61 800	69.300	70,000	9,950	13,200	15,350
	7,860	79,900	89,500	87,600	12,800	17,000	19,200
	8,880	91,000	101.900	96,200	14,700	19,400	21,100
	9,440	97,500	105,400	101,000	15,700	20,000	22,140
Armature 5⅜ in. in diameter, 72 teeth.	3,280	24,300	26.800	28 600	6,070	8,130	10,560
	5,810	40,300	44,900	46,000	10,080	13,600	17,000
	7,270	50,900	57,800	45,300	12,700	17,500	21,160
	8,380	58,400	66,200	62,300	14,600	20,100	23,000
	8,870	61,300	68,900	64,400	15,300	20,900	23,800
Armature 5 7/16 in. in diameter, 36 teeth.	2,680	36,100	43,400	43,500	4,280	6,020	7,450
	5,260	68,400	83,100	83,700	8,100	11,540	14,350
	7,630	100,700	122,000	122,700	11.900	16,950	21,000
	9,200	122,400	145,800	142,200	14,500	20,200	24,400
	10,000	133,300	154,100	150,200	15,800	21,400	25,700

CONCLUSION.

The experiments described in the present paper occupied the greater part of two years, and the expense of constructing the apparatus and photographing the stream-line slides was defrayed out of a research grant made by the Royal Society. We are indebted to Professor E. W. Marchant, D. Sc., and several of his students for valuable assistance in connection with the somewhat laborious experiments which form the subject of our paper.

A Visit to the Amsterdam-Haarlem Electric Tramway.

During the latter part of November a party of engineers and representatives of the technical press, upon the invitation of Messrs. J. G. White & Company, left London for a visit to Amsterdam, Holland, where the new electric railways were inspected. These are the Electrische Spoorweg Maalschappij, Haarlem, and they embrace the line from Amsterdam to Haarlem, about twelve miles in length—an entirely new road—and an older tramway from Haarlem to Zandvoort, a popular seaside resort. The latter road has been double-tracked and partly reconstructed. This construction was necessitated by the sandy nature of the soil. The cars of this company, after reaching Amsterdam, run over the tracks of the municipal tramways to the centre of the city. The total cost of the road, rolling stock, car-sheds and power-house is said to have been about $1,500,000.

The Domestic and Foreign Jurors in the Electricity Section of the International Jury of Awards of the Universal Exposition, St. Louis, Mo., 1904.

The accompanying group photograph of the domestic and foreign jurors in the electricity section of the international jury of awards of the Universal Exposition, St. Louis, 1904, is presented through the courtesy of Mr. W. J. Hammer, of New York city. Below will be found a complete list of the jurors, the numbers adjacent to the names corresponding to the indices of identification on the photograph. The classification and designation of the jurors follow:

GROUP 67—MACHINES FOR GENERATING AND USING ELECTRICITY.

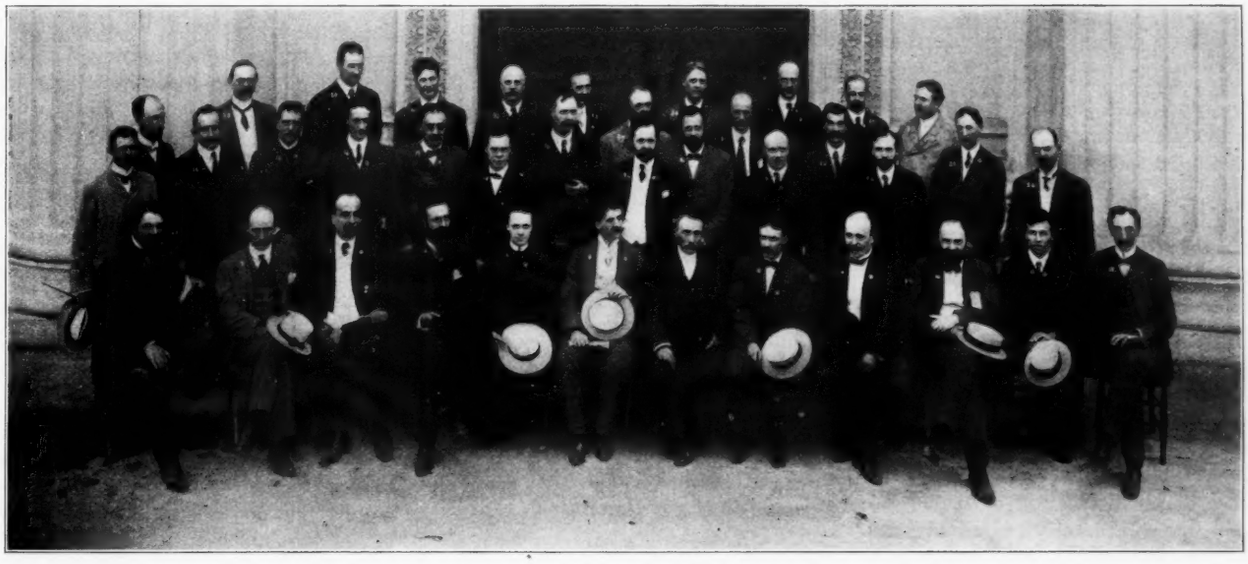
0—W. V. N. Powelson, chairman.

GROUP 69—ELECTRIC LIGHTING.

0—Harold B. Smith, chairman.
7—Guido Grassi, vice-chairman.
18—B. V. Swenson, secretary.
23—George D. Shepardson.
24—Warren Edward Weinsheimer.
0—C. A. Adams.
10—Alfred Dennery.
22—F. P. Anderson.
33—E. L. Nichols.
8—Professor W. E. Goldsborough, chief, department of electricity.
9—Dr. Kahle.

GROUP 70—TELEGRAPHY AND TELEPHONY.

20—William J. Hammer, chairman.
4—Gaston Roux, vice-chairman.
16—Professor A. S. Langsdorf, secretary.
3—A. I. da Costa Couto.



DOMESTIC AND FOREIGN JURORS, ELECTRICITY SECTION, INTERNATIONAL JURY OF AWARDS, UNIVERSAL EXPOSITION, ST. LOUIS, MO., 1904.

6—G. Holschuch, vice-chairman.
26—Professor H. H. Norris, secretary.
5—E. Solari.
34—C. W. Wason.
0—P. O. Keilholtz.
0—H. Floy.
31—E. P. Roberts.
0—F. G. Baum.
36—Professor J. P. Jackson.
32—O. T. Crosby.
37—Professor G. F. Sever.
11—H. Shibusawa.
0—H. H. Gerry.
0—Professor R. B. Owens.
0—J. W. Esterline.

GROUP 68—ELECTROCHEMISTRY.

21—Carl Hering, chairman.
25—Charles F. Burgess, secretary.
38—Samuel Sheldon.
12—K. Sosnowski.
17—Dr. F. B. Herzog.
30—Professor J. C. Kelsey.
0—Dr. A. E. Kennelly.

GROUP 71—VARIOUS APPLICATIONS OF ELECTRICITY.

19—E. B. Rosa, chairman.
2—Dr. C. V. Drysdale, vice-chairman.
13—M. C. Buckey.
14—Dr. F. A. Wolff.
27—Dr. Frederick Bedell.
15—Dr. William J. Morton.
1—M. Andre Silva.
28—Dr. K. E. Guthe.
29—Colonel Samuel Reber.

A Homopolar Dynamo.

In view of the interest which has recently been revived in unipolar dynamos, it may be of interest to present a provisional design of a homopolar dynamo which formed part of a thesis offered by Mr. George H. Gibson, at the University of Michigan, in 1899.

The machine is to deliver 1,000 amperes at fifty volts, and in order to keep the weight and cost of the machine as low as possible, it was thought best to use a relatively large number of conductors in series, together with a high gap density and velocity of conductor. The gap density decided on was 28,600 lines per square inch, and the velocity of the conductors was 139.2 feet per second. The armature was built of ten layers of sheet copper, No. 24 B. & S. gauge, with intervening layers of insulation one-thirty-second of an inch thick. The copper sheets were soldered or brazed where the edges met, and a winding of No. 20 piano wire was applied to the outside to resist centrifugal force. The clearance assumed between the poles and the armature is one-eighth inch. The air-gap is 0.87 inch. The permeability of steel at a density of 90,000 lines per square inch was taken at 1,100, which is perhaps too high. The length of the magnetic circuit in the steel is thirty-seven inches. The ampere-turns necessary to excite the magnets were as follows: air-gap, 7,201; field, 957; iron pulley or spider, 7. The total excitation is a little over one per cent of the total output. The weight of the machine would be approximately 1,500 pounds, of which 320 pounds would be copper. The weight efficiency would be about thirty-eight watts per pound.

Reviews of Current Engineering and Scientific Literature.

Electrolysis by Means of Alternating Currents.

A thorough investigation into electrolytic action, as produced through alternating currents, has been made by Herrn. Andre Brochet and Joseph Petit. They here give a bibliography of the subject and a detailed description of the apparatus employed and the methods used. The following are their conclusions. The frequency does not always affect the result in the same sense. In certain cases the deposition decreases as the frequency increases. In others the deposition increases with increasing frequency, passes through a maximum, and then decreases. With platinum, however, the maximum was not reached. The same remarks apply to the effect of current density, the deposition increasing quickly with the current density, passing through a maximum, and then falling more or less sharply. It is impossible to predict the general conditions of alternating-current electrolysis, as they can only be determined by systematic study. The authors found that copper, zinc, nickel, cobalt and other similar metals dissolve in potassium cyanide under the influence of alternating current, because of the ease with which the anode is dissolved and the difficulty with which a deposit is made on the cathode. Silver, cadmium and mercury, which are easily deposited upon the cathode, do not dissolve under the influence of an alternating current. Mechanically or chemically pulverized platinum dissolves spontaneously in a cyanide solution. Iron dissolves with an alternating current, but shows an entirely different condition.—*Translated and abstracted from Zeitschrift fur Elektrochemie und Angewandte Physikalische Chemie (Halle a. S.), December 2.*

Electric Signal Lighting on the Lancashire & Yorkshire Railway.

The electrification of a few signal lanterns on the Lancashire & Yorkshire Railway was first tried experimentally six years ago, at Victoria station, Manchester. The results were satisfactory and brought about the adoption of this method of illuminating more than 200 signals at Bolton New Station. This equipment is here described by "Verax." It comprises an electric pneumatic signaling system, with twenty-one cranes, seventeen electric capstans, six lifts, eighteen electric jiggers and 800 electric lamps. The earlier method of mounting the incandescent lamps in the signal lanterns was by means of a short pipe bracket. It was found that the throwing of the semaphores caused frequent breakages of the lamp filaments. The lamps are now suspended by a short piece of flexible cord and give no further trouble in this respect. The oil lamp is lifted out and the incandescent lamp is attached to the cover of the lantern by means of a spring clip, the flexible cord being long enough to bring it to the proper point. Eight-candle-power, 230-volt lamps are used, but the voltage of the circuit is only 220. The effect of running the lamps on this lower voltage is to increase the life greatly. At the same time, the quality of the light given by the filament meets all requirements. These lamps are controlled from the signal station, so that they can be lighted by the signal man in the evening and in case of sudden fogs. The ability to do this gives the system a great advantage over oil lamps. At the same time, in case of a breakdown of the entire system, the incandescent lamps are easily lifted out and their place taken by the usual oil lamp. Current is carried to the lamps by means of underground conduits. The circuits are subdivided so that there are, in general, not more than two lamps on any one fuse, though in a few cases there are three.—*Abstracted from the Electrical Review (London), December 2.*

A New Arrangement of Resistance Box Contacts.

A new design of potentiometer for use with Le Chatelier pyrometers is here described by M. H. Armagnat. The general arrangement does not differ from that customary, but the method of making contact between the terminal blocks on the box is new and is said to have a number of important advantages. The old method of making such contacts, as is well known, is by means of a tapering plug which is inserted in a tapering opening between two adjacent blocks. While this method is in general use, it has two objections. One is the continual wedging apart of the terminal blocks, tending to loosen them; the other is that it is difficult to clean the blocks so as to obtain a reliable contact resistance. It is these two objections that the new form of terminal and key is designed to eliminate. The key or plug is in the form of a T-headed screw with a milled nut. The gap between two adjacent terminal blocks is made rectangular at the top, but below is cylindrical. The key is inserted with the T-head down through the rectangular slot, and the milled nut is then turned, turning the head until it comes in contact with two pins attached to the terminal blocks within the cylindrical gap. Further motion of the milled head screws it up until the terminal blocks are clamped securely between it and the T-head. To remove the plug, the milled nut is turned in the opposite direction, which first loosens the screw and turns the T-head until it comes in contact with the pins mentioned above in the opposite sense. It is then in a position to be lifted directly out of the rectangular slot. With this form of key there is always a firm contact between the adjacent blocks. The act of inserting the plug cleans the surface of the blocks, and in this way a small and constant contact resistance is obtained. This, it is said, is not more than 0.0001 ohm, and does not vary more than one or two microhms.—*Translated and abstracted from La Revue Électrique (Paris), November 30.*

The Use of Iron in Alternating-Current Instruments.

At a recent meeting of the Birmingham local section of the Institution of Electrical Engineers, of Great Britain, Dr. W. E. Sumpner delivered an address on "The Use of Iron in Alternating-Current Instruments," an abstract of which is here given. After discussing the various types of electrical instruments, and showing why, as a rule, alternating-current instruments are less sensitive than those for direct current, due principally because it is usually assumed that iron may not be employed in the former, several instruments were described, in which iron is not objectionable. The first type to be considered is the power-factor indicator. A satisfactory instrument of this kind has been constructed, in which the fixed coils which set up a rotating magnetic field are wound through circular-ring stampings, just as in the stator of a three-phase motor. There are three coils, each of eight turns, wound with wire suitable for five or six amperes, and each coil brought to a separate pair of terminals. That portion corresponding to

the rotor consists of a cylindrical block of circular stampings, held in a fixed central position and unwound. In the air-gap between the two is placed a pivoted coil similar to those used on moving-coil galvanometers, but without control. It is capable of free motion about the axis of the instrument and its position is indicated on the scale by an attached pointer. The position taken up by the pointer is quite definite under any given circumstances, and the forces tending to make it return are considerable, in spite of the fact that a very large non-inductive resistance is used in series with the pressure coil. To introduce electromagnets into wattmeters is more difficult. It is usually assumed that a considerable error is caused if the current in the pressure coil lags behind the pressure, but this error is not as large as might be thought. A table showing the error caused by one degree lag in the pressure coil for a fixed load current corresponding to 1,000 volt-amperes and for different power-factors is given. The error increases the reading if the load current lags, and diminishes if it leads. When the power-factor is unity the error is only 0.03 per cent; with a power-factor of ninety, it is less than one per cent, and it is less than two per cent when the power-factor is seventy. The error, instead of increasing indefinitely as the power-factor increases rapidly, attains a maximum value which is less than two per cent of the reading corresponding with the same current if non-inductive.—*Abstracted from the Electrician (London), November* 25.

The Substation of the Helena, Mont., Light and Traction Company.

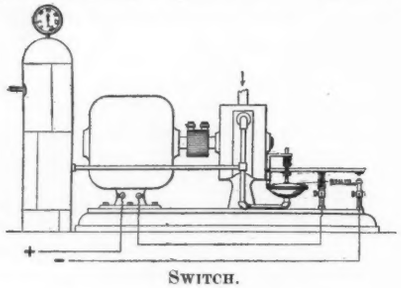
The old substation of the Helena Light and Power Company, Helena, Mont., was destroyed by fire in the fall of 1901. A temporary substation was put into service within a few hours, and now a permanent substation has been built and equipped, and is in full operation. It was decided, in this substation, to depend upon transmitted power only, eliminating all steam-driven units. This enabled the substation to be located centrally, and eliminated the maintenance of nearly a mile of heavy distribution lines. The new building is faced with an extremely hard porphyry of light pink tint, relieved with cut stone trimmings. Every precaution known to the builders' art has been taken against fire, and equally thorough have been the efforts that have been exerted to perfect every mechanical and electrical engineering feature throughout the plant. The building has a frontage of forty feet by eighty-five feet, and is a single-story structure. There is a basement seven and one-half feet in height. The walls of the entire structure are rubbled stone, the side walls being two feet eight inches thick, while the thickness of the rear and front walls is three feet. The basement contains all machine leads and buses. The roof is of iron trusses and purlins, and is covered with expended metal embedded to a depth of eight inches in cinder concrete, the whole being covered with No. 18 corrugated steel. The electric service for Helena is derived solely from a separate transmission line from Canyon Ferry. The only additional power taken therefrom consists of some 2,000 horse-power required for the operation of the smelters at East Helena, some four miles distant from the city. Two three-phase, 11,000-volt lines enter the substation at the rear. The lighting transformers are provided with seventeen secondary taps and a potential regulator face-plate giving a range of regulation amounting to 400 volts on the secondaries. There are nine of these transformers, and space is provided for three additional ones. Three have an output of 450 kilowatts. These are used for operating two 175-kilowatt rotary converters, two seventy-five-kilowatt motor-generator sets and three Hartford transformers for the series alternating-current arc circuits. The remaining six transformers deliver 2,200 volts from the secondary coils. The first bank of three has an output of 175 kilowatts; the remaining bank an output of 540 kilowatts. Details of the arrangement of apparatus and circuits in the substation are given. The most striking innovation of an electrical nature is the method devised for exciting the rotaries—either singly or in parallel—from a separate source that is entirely independent of the rotaries themselves. It was found that when the rotaries were self-exciting, a lighting discharge invariably threw them out of step, bringing out the circuit-breaker. The new method of excitation has entirely eliminated this difficulty. At present the station is delivering a load aggregating 30,000 sixteen-candle-power incandescent lamps.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), December.*

Inspection and Maintenance of Overhead Trolleys.

An investigation of the methods followed in inspecting electric railway conductors in Europe has been made by M. G. Pedrialli, chief engineer of a Brussels electric railway. The necessity of a periodic and detailed inspection of the line insulation is recognized, but not all the companies investigated do this. In general, faults are not remedied until they become serious. The simplest way of testing the insulation resistance is by means of a high-resistance voltmeter, but this is only accurate when the line insulation resistance is low. Where more careful determinations are desired, a galvanometer is employed. For conduit systems or surface-contact systems the resistance from working conductor to ground is tested daily, since on these lines there are twice as many insulators to be maintained, and there is, further, a tendency for humidity to collect on the negative conductor. With such a system it is advantageous to be able to reverse the polarity of the working conductors. One part of the conducting system of electric railways which needs special attention is the rail joints. If the current flowing through the rail be known, a bad joint is quickly detected; but the usual methods of measuring the current in the rail are unsatisfactory. Certain companies provide for introducing an ammeter into the return conductors where they are connected to the rail, but even this does not give the true value of the current carried by the rail. It has been found from experience advisable to prevent a difference of potential between rails and neighboring pipe of more than one volt. If the railway company has a telephone system at its disposal, it is easy to make tests of the track return by means of the telephone wire as a pilot wire; but these tests should not take the place of periodic inspection of every joint. Many companies test regularly the insulation of their overhead conductors. When the working conductor is suspended by a span wire, the insulation between the span wire and the trolley wire, and the insulation from the span wire to the ground, may be determined by voltmeter readings, as follows: let A be the difference of potential between the trolley wire and the span wire; B, the difference of potential between the span wire and the ground, and C the difference of potential between the trolley wire and the ground. If, then, R be the resistance of the voltmeter, and X and Y the resistances of the trolley insulator and of the span wire insulator, we have $X = \frac{R}{B}$ (C—A—B), and $Y = \frac{R}{A}$ (C—A—B). It is advisable to take these readings both to the left and to the right of the trolley wire as a check. When a fault can not be found by inspection, Girard's method of locating it is useful. This consists in sending an interrupted current over the line and exploring for the fault by means of a telephone receiver and a coil. The interrupted current is obtained by working a small make-and-break switch by means of a small motor. The circuit should be adjusted so that the current sent into the line is about five amperes. Where overhead ears are used, the trolley wire wears just beyond these, and it has been found helpful to place a small sleeve of sheet copper over the wire at this point. The suspension of overhead wire should be elastic, and ears thirty-eight centimetres in length seem to give the best results. The life of a trolley wire varies from 500,000 to 1,500,000 passings of the wheel.—*Translated and abstracted from L'Électricien (Paris), December* 3.

Electrical Patents.

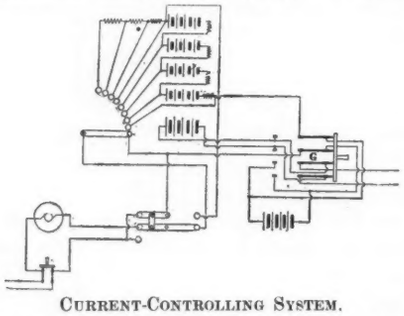
An improvement in switches, more particularly electric switches, the object of which is to provide a quick make-and-break device, has been invented (776,545, December 6) by Mr. Edwin F. Porter, of Boston, Mass., and the patent obtained thereon has been assigned to the Porter Air Compressor Company, of Kittery, Me., by mesne assignments. An air-pressure pump is provided having an air



SWITCH.

inlet and an air outlet. A storage reservoir is employed for the air. The pump is operated by an electric motor, and the motor in turn is operated by an electric circuit, which is opened and closed by a switch lever. A buckled diaphragm is controlled by the pressure from the pump for operating the switch lever as it passes to opposite sides of its dead centre line.

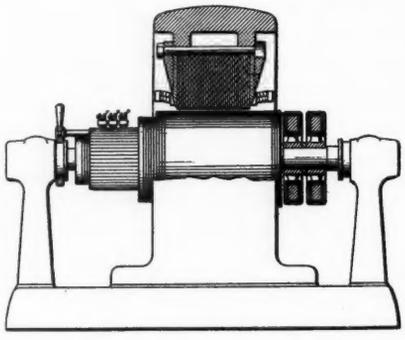
Mr. William R. Whitehorne, of Bethlehem, Pa., has recently devised and patented (776,878, December 6) improvements in current-controlling systems. The object of the invention is to provide a system for controlling the speed of a motor by which any desired number of storage-battery cells may be employed to vary the motor speed in place of a rheostat, as customarily used, it being also desired to arrange the electrical connections of the apparatus so that certain of the cells may be used interchangeably with an independent group of cells,



CURRENT-CONTROLLING SYSTEM.

thereby always rendering available a full-charged battery for supplying low-voltage current for any purpose, as, for example, to the key-desk of an organ. It is also the object to provide means for avoiding the short-circuiting of the battery cells or group of cells while the controlling switch is being operated. A further object is to so arrange and connect a group of battery cells relatively to a motor and supply mains that a single switch may be used for causing the electromotive force of the cells to either oppose or become additive to that tending to force current through the motor, another object being to provide a switch by which this end may be accomplished. The system includes three groups of battery cells. A line is employed to be supplied with current, also a motor, and current-supply mains. Means are provided for connecting either of two of the groups of cells to the line to be supplied with current, and the remaining groups of cells with the motor to the supply mains, the connection of the remaining groups of cells to the supply mains including means whereby their electromotive force may be either added to or subtracted from that of the supply mains. Means are also employed for varying the number of cells of the third group in circuit.

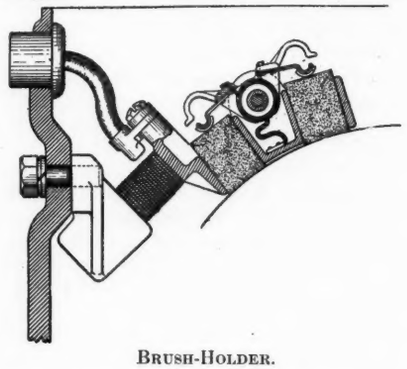
An alternating-current motor is the subject matter of a patent (775,439, November 22, 1904) recently granted to



ALTERNATING-CURRENT MOTOR.

Ernst J. Berg, of Schenectady, N. Y., the interest in which he has assigned to the General Electric Company. The invention has particular reference to alternating-current motors of the commutator type, and the object is to provide an efficient form of motor in which only one-half the usual number of sets of brushes are used. This reduction in the number of brushes is important, not only as regards brush friction and commutation losses, but also as it permits the several sets of brushes to be spaced far apart even in a motor with a large number of poles and with parallel windings, which, with the usual construction, would necessitate two sets of brushes per pair of poles. The invention comprises a rotor winding provided with a commutator, a plurality of compensators revolving with this rotor winding. Each compensator is connected to points on the rotor winding displaced by 180 electrical degrees and the neutral points of the several compensators are connected and form one terminal of the rotor winding. Brushes are provided bearing on the commutator and forming the other terminal of the rotor winding.

An improvement in brush-holders has been patented (776,546, December 6) by Edward D. Priest, of Schenectady, N. Y., and the patent obtained thereon has been assigned to the General Electric Com-



BRUSH-HOLDER.

pany. The object of the invention is to provide an improved brush-holder whereby two brushes arranged in tandem may be pressed against the collector-ring by a single spring. In the embodiment of the invention, the holder-ring is suitably supported adjacent to the collector-ring by means of an insulated stud, projecting from a support, secured to the frame of the machine. The holder has two sockets for the carbon brushes, which stand radially to the collector-ring and are pressed against it by means of levers or followers, hinged on a common pivot pin, supported in the holder. To give a long bearing to each follower the hub of one may be sleeved on that of the other. Surrounding the tube is a helical spring, the ends of which are respectively engaged with the two followers so that each follower serves as an abutment for the other, and both are pressed against their brushes with an equal force. In order to give the followers enough play, they are offset where they join their hubs, leaving an open space between their opposite edges. In order to increase the range of movement these edges may be oblique to the line of movement, but parallel with each other. Each follower has a hook to serve as a finger-hold for convenience in raising it to release the brush when desired. Each follower carries a pressure-spring which is a strip of phosphor-bronze secured to the follower and provided with a laminated covering of copper in contact with the follower and with a segmental circular copper tip, which is secured to the end of the pressure-spring and rests on the outer end of the brush.

Wireless Telegraphy from the Washington Standpoint.

By George C. Maynard.

THE headquarters of the largest and most successful wireless telegraph organization in this country is in Washington. Its office is in the bureau of equipment of the navy department. Rear-Admiral H. N. Manney is chief of the bureau and Lieutenant-Commander Joseph L. Jayne, one of his assistants, is in immediate charge of all wireless telegraph matters.

The United States Navy, in having among its officers many experienced and efficient electrical experts and in possessing unusual facilities and almost boundless resources for experiments under all conditions, on land and at sea, is better prepared for testing, developing and putting into practical use the new method of transmitting intelligence than any other organization anywhere.

Preparation for this class of work may be said to have commenced in 1872 when the late Professor Moses G. Farmer was engaged to conduct experiments and give instruction in electrical engineering to young naval officers at the torpedo station at Newport, R. I. At that time the principal experiments were connected with the use of submarine mines and torpedoes. As electrical science and art developed the navy enlarged its field of investigation and every new discovery and invention which gave promise of usefulness in the service was tested, and if found of utility was put into practice. This course of training fitted many officers to deal intelligently with any electrical problem, and when the invention of wireless telegraphy was announced, they were ready to take it up. The very inception of the system and the first demonstrations made by Marconi aroused their active interest, and investigations as to its merits were immediately begun. Since that time the subject has received constant study, not only in its technical aspects, but in all phases of its possible relations to the government service and to private corporations and individuals, both in time of peace and in war. At the same time other departments of the government have been devoting much time and study to the subject. The signal corps of the army, the weather bureau, the lighthouse board and the life-saving service, all of which have need of communication with places not reached by land or submarine lines, at once realized the great advantage of wireless telegraphy in carrying on their work and took measures to secure such facilities as it might afford.

The fact that the various departments of the government worked entirely independent of each other, and with a little feeling of rivalry, and the further fact that enterprising private companies were establishing numerous stations at various points along the coast, led to more or less confusion and friction, and at times the electrical interference between stations became so great that it was impossible to operate any of them in a given district. The most serious difficulty of this kind was experienced at New York, Boston and Newport. The situation became so critical that, about five months ago, President Roosevelt took a hand in the business and appointed a special interdepartmental board to consider the entire question of wireless telegraphy in the service of the national government and report to him. This board was composed of Rear-Admiral Robley D. Evans, Rear-Admiral Henry N. Manney, Brigadier-General A. W. Greely, Lieutenant-Commander Joseph L. Jayne and Professor Willis L. Moore.

Among the papers submitted to the board was a communication from the Secretary of Agriculture who took the position that his department was the proper one to control and manage all the government's wireless telegraph service on land. That department already had authority to maintain and operate an extensive system of seacoast telegraph lines for the collection and transmission of marine intelligence for the benefit of commerce and navigation, in charge of experienced men, and the secretary argued that "if the needs of commerce and the protection of our country, in times of peace or war, should require that the United States government should control and operate seacoast wireless telegraph stations, I would respectfully submit that the department of agriculture is equipped to efficiently establish and operate such stations, and information as to the passing of ships of commerce or vessels of war would be furnished to the navy department as accurately and expeditiously as it is possible to do such work." To this proposition the navy department dissented and replied that "as the principal use to which wireless telegraphy is likely to be put for many years is connected with the sea, and on account of the confusion that may arise from numerous stations being established in the same locality, it would be advisable to put all government wireless telegraph stations on or very near our seacoast, under the navy department, and perhaps to have the government take control of the entire wireless telegraph service along the coast." The navy department further explained that in time of war it would be absolutely necessary that observers and operators stationed to receive messages from the fleet should be subject to military law and that such men must be trained in time of peace in order that they may be ready for service when war comes.

The board made an exhaustive examination of the entire subject and found that the navy had in operation twenty shore stations, the army had established six stations, the weather bureau had two, and all of these departments were either actually constructing or had in contemplation the erection of others. The navy had twenty-four ships equipped with wireless apparatus and were preparing to extend the sea service. Numerous stations equipped with Marconi, Fessenden and De Forest apparatus were also in operation, and these systems were being rapidly extended. The New York *Herald* was operating its original Marconi stations at Siasconset and on the Nantucket Shoals Lightship, while the Providence *Journal* had several stations in the vicinity of Narragansett bay. On the Pacific coast a private company had several stations and was pushing its business. The competition between the various interests, governmental and private, had led to the establishment of two stations in certain localities where there should have been but one. In several instances private companies were pressing their applications for permission to erect stations in choice locations on government reservations.

The board fully realizing the necessity of prompt action to avoid most unfortunate confusion and unnecessary duplication, adopted the resolution:

That all installations of government wireless telegraph stations be suspended except at stations now under contract, until the final report of the board is acted upon by the President. That all departments of the government interested in wireless telegraphy should refuse to allow any private

company to install a station on any government reservation until so authorized by proper authority.

And it recommended that the weather bureau should discontinue its wireless telegraph service; that the war department should be authorized to establish stations only where they are absolutely necessary for the army service and to provide facilities which could not otherwise be secured, and that all other government wireless business should be put under the control of the navy department. The plan proposed contemplated the extension of the naval system to cover the entire coasts of the United States, its insular possessions and the Panama canal zone, and provided for cooperation of all departments interested in the service. For the regulation of private stations in the interior of the country it was recommended that they be placed under the supervision of the department of commerce and labor. The President promptly approved the report of the board and directed that its recommendations be put into effect.

The result of the action mentioned above, while depriving the weather bureau of one important branch of its service, added to its duties the management of a still more important field of work by assigning to it the control of the entire ocean meteorological service which has heretofore been done by the navy department. Under this arrangement the bureau is to receive weather reports from all naval vessels equipped with wireless apparatus, whenever they are able to send them in, and is to furnish reports of weather indications to vessels at sea. This plan will immensely increase the service of the weather bureau and greatly enlarge its field of usefulness. The naval observatory is also to utilize the wireless system in distributing its daily time signals which are already going out to sea from a considerable number of coast stations. As aerial telegraphy progresses and its discordant notes are eliminated, the ticks of the Washington clock will be watched for and heard by every ship, of whatever nationality, that raises a wire to receive them. The possibilities and advantages of this service, which could be performed by no other government, can not be overestimated. Moreover, the United States government would be unable to carry on this work without the cooperation of the commercial telegraph companies which are always given the use of their extensive systems of land lines and submarine cables free of all charge.

On one point the board took an exceedingly radical or, at least, a very novel position. It recommended that all wireless telegraph stations in the United States be put under full governmental supervision in order to regulate them for their mutual and the public welfare, as well as from considerations of national defence, and then adds, "it seems desirable that there should be some wholesome supervision of them to prevent the exploitation of speculative schemes based on a public misconception of the art."

In carrying out the President's instructions the navy department immediately commenced the preparation of regulations for the conduct of the business and these have just been issued. Under these regulations the facilities of the naval coastwise stations, including the one on the Nantucket lightship, for communication with ships at sea, while not in competition with private wireless telegraph stations, are placed at the service of the public generally and of maritime interests in particular, free of charge by the government. All messages will be subject to tariffs of ship stations and land lines, and patrons must arrange with private companies for the payment of their charges. The Western Union and the Postal Telegraph companies have agreed to accept messages transmitted through the navy wireless stations without prepayment of tolls. Maritime exchanges, chambers of commerce, newspapers, news agencies and others can arrange for having vessel reports and general marine news forwarded to them regularly by communicating with the Bureau of Equipment. Messages for the Cape Ann station are to be forwarded *via* the navy yard, Portsmouth, N. H. The Nantucket Shoal Lightship will transmit its messages to the torpedo station, Newport, R. I. All messages intended to be sent *via* this lightship to ships at sea should be sent to the torpedo station. Messages for the Montauk Point wireless telegraph station will also be sent *via* the torpedo station, Newport, R. I. Arrangements have been made with the weather bureau for the transmission of messages between the Cape Henry wireless telegraph station and Norfolk. All messages intended for the Cape Henry station should be sent *via* the weather bureau, Norfolk, Va. All messages intended for Dry Tortugas should be sent *via* the naval station, Key West, Fla. The station at Yerba Buena, Cal., can be reached by either the Postal Telegraph or the Western Union system and the one at Mare Island by the Western Union. The Farallon station will communicate with Yerba Buena Island, Cal.

At this time the navy has in operation seventeen coast stations located at the following places: Navy Yard, Portsmouth, N. H.; Cape Ann (Thatcher's Island); Highland Light, Cape Cod, Mass.; Nantucket Shoal Lightship; Torpedo station, Newport, R. I.; Montauk Point, L. I.; Navy Yard, New York; Highlands of Navesink, N. J.; Cape Henry, Va.; Navy Yard, Norfolk, Va.; Dry Tortugas, Fla.; San Juan, P. R.; Culebra, W. I.; Yerba Buena Island, Cal.; Navy Yard, Mare Island, Cal.; Naval Academy, Annapolis, Md.; Navy Yard, Washington, D. C.

Nine other stations are now in course of erection and, it is expected, will be ready for service in the course of a few weeks. The plans of the department contemplate the rapid extension of its wireless system by the early establishment of sixteen more stations along the Atlantic coast from Maine to Florida, eight stations on the shores of the Gulf of Mexico, fourteen on the Pacific coast, from San Diego to Sitka, and thirteen in the Philippines, Midway Islands and Samoa. Of the naval vessels now equipped with and constantly using the wireless telegraph there are twenty, including battleships, cruisers, despatch boats and monitors. Equipments have already been ordered for nine other vessels and it is proposed to fit out fifty-three additional vessels as rapidly as it can be accomplished. The naval land stations and ships are equipped with apparatus of several systems, mostly of foreign types, and can communicate with all the principal systems now in use if tuned to the same wave-length. The best results are obtained when both the sending and receiving apparatus are tuned to the wave-length of 320 metres, and when the speed of sending does not exceed twelve words per minute. In a few instances Fessenden and De Forest apparatus is used on shipboard, and some of the ships are provided with two sets of apparatus of different types.

One of the most important pieces of work now being done is the erection of five land stations to connect Florida with Cuba, Porto Rico and the Panama canal zone. These stations will provide telegraphic circuits as follows: Key West to Pensacola, 550 miles; Key West to Guantanamo bay, Cuba, 525 miles; Key West to San Juan, P. R., 1,175 miles; Key West to Colon, Panama, 1,025 miles; Guantanamo to San Juan, 525 miles;

Guantanamo to Colon, 775 miles; San Juan to Colon, 1,100 miles. The work is being done by the Navy Department and the American DeForest Wireless Telegraph Company jointly, under a contract executed July 8, 1904, which stipulates that the department shall, within five months from that date, complete the erection of buildings, masts, etc., and supply all necessary machinery to provide an alternating current of sufficient power to operate the transformers furnished by the DeForest company. The Pensacola station is to have two masts, 180 feet high, the others three masts 180 feet high and about 150 feet apart. The DeForest company agrees to furnish and install at each of the four larger stations one thirty-five-kilowatt transformer, 110 to 30,000 volts, capable of standing a voltage of 60,000, one reactance regulator for regulating output and spark frequency, glass plate condensers in oil, syntonizing helix and spark-gap, relay transmitting key, American DeForest receiving apparatus with telephone attachment and call-bell, antenna wires and earth-plates and all necessary instruments, wires, tools and accessories for successfully operating the apparatus. The Pensacola station is to be fitted with a ten-kilowatt transformer, 110 to 30,000 volts. The DeForest company guarantees to complete the installation of all these stations and to have them in successful operation within six months from date of contract; that it shall furnish intercommunication between all the stations and with all naval vessels within its range, and to furnish skilled operators to care for and use the apparatus for such time as may be necessary to satisfy the department that the conditions of the contract have been fulfilled. It also guarantees the government against all claims for infringement of patents and has given bond for faithful performance of its agreements. When this group of stations is completed and turned over it will be the property of the government and under its absolute control. Statements have been published to the effect that the DeForest company will have the right to use the stations for commercial business, but this is incorrect.

The manœuvres of the United States naval fleets which are to take place in the Caribbean Sea during the winter will afford an unusual opportunity for utilizing and testing wireless telegraphy and the department is preparing to have this done in the most thorough manner.

A clause in the protocol agreed upon in the preliminary wireless telegraph conference between Germany, Austria, Spain, the United States of America, France, Hungary and Russia, declares that "all stations whose field of action extends to the sea are called coastwise stations." If the present plans of the government are carried out, and if the leading wireless telegraph authorities realize their hopes and beliefs, that their apparatus will soon be transmitting messages between stations five-hundred miles or more apart, Montpelier, Albany, Harrisburg, Washington, Lynchburg and Atlanta will become "seacoast" cities, and there will be no point in the entire Appalachian mountain range where a wireless station would be outside the jurisdiction of the United States navy.

The action of the government in practically assuming control of the wireless telegraph business of the country has had the effect of checking the enterprises of some of the private companies, although the power of the government, under existing laws, to adopt such measures is questioned, and the views of Congress on the subject are anxiously awaited. A bill embodying the recommendations of the interdepartmental board has been introduced in Congress and is expected to bring about an investigation of the many intricate problems involved at which all interested parties will be given opportunity to submit facts and arguments.

General H. H. C. Dunwoody, vice-president of the American DeForest Wireless Telegraph Company, has a fine suite of rooms in the Colorado Building. He gives especial attention to the business of his company with the government for which his long experience with telegraphic matters in the Army Signal Corps and his familiarity with departmental affairs eminently fit him. The company is building an experimental station three miles east of the city with a view of establishing communication with Baltimore and is installing plants on two of the Mallory Line steamers.

The National Signaling Company's Washington station is located down on the bank of the Potomac river, surrounded by machine shops, lumber yards and fish wharves, with hills on every side and the dome of the Capitol between it, and the company's stations in Philadelphia and Jersey City. Near-by are the offices, well equipped laboratories, workshops and testing rooms where Professor Fessenden can generally be found, with a corps of assistants hard at work. Just now they are executing a contract with the Mexican government for a number of stations intended for use in the interior of that country with capacity for communication over distances ranging from seventy to two hundred and fiftv miles. The company is also putting a plant on one of the naval vessels.

Ever since the Marconi system was introduced and its success demonstrated, the Navy Department has been desirous of availing itself of such advantages as it might offer, but the Marconi company has not been willing to furnish apparatus on the government's terms which are, practically, to purchase it at a fair price and use it as it pleases. The company evidently preferred to hold the whip hand. It asked the government to pay a yearly royalty of $50,000 for the right to use its apparatus which was to be purchased at "the current market price," and use it only for communication with stations and vessels equipped with Marconi apparatus, except in time of war. The company also asked the government to make such arrangements as would prevent interference with vessels of the mercantile marine, equipped with its apparatus, when communicating with naval vessels. It announced its intention of going extensively into commercial business in the United States and wished to utilize government stations in carrying it on in exchange for similar courtesies to the government. Negotiations between the government and the Marconi company are still being carried on.

At various stages in the course of wireless telegraph developments, there have been slight suggestions of the practice which has sometimes prevailed, by which one department of the government guarantees to a citizen the exclusive right to his invention and another department of the same government takes it away from him.

The question of the use of wireless telegraphy as an adjunct to wire telegraphy and telephony is receiving serious consideration. The entire suspension of direct-wire communication between Washington and Baltimore, caused by a heavy snowstorm a month ago, forcibly called attention to the possible utility of the new system for such emergencies. Even at the comparatively slow rate of wireless transmission it would be of great value. On the other hand there can be no doubt that wire communication between experimental wireless stations would greatly facilitate their operation. What seems to be needed is less suspicion and hostility and more friendliness among the owners and advocates of the different systems. The common notion that such a great invention as wireless telegraph must necessarily overturn and destroy old methods is too absurd for toleration.

The determined spirit of the wireless enterprise which continually demands higher masts and more powerful currents, recalls the experience with the first Atlantic cable, when, after several years had been spent in devising and manufacturing batteries of the largest size, it was discovered that the very smallest were more suitable. There are intelligent persons who have studied the subject and who believe that another year will see almost as great changes in wireless systems, and that such changes will be in the same direction.

LIGHTNING PROTECTION.[1]

BY J. V. E. TITUS.

From the reports of lightning troubles that reach us this year from the electrical companies of Colorado I gather that it is time that we added our knowledge, as we surely need the progress. In no other branch of the electrical field has engineering ability such an uncertain factor to deal with. The vagaries of lightning discharges are recounted in practically every issue of the daily press and I believe that each one of you realizes fully that one of the most serious problems we have to deal with is the matter of lightning protection.

There are two kinds or classes of discharges that have to be dealt with. One is the direct discharge from the clouds to the earth, commonly called a bolt of lightning; the other the induced charge which builds up during storms on all overhead circuits. With the former, fortunately, we have very rarely to deal, as when such a discharge strikes an electric circuit the tremendous energy that has to find an outlet to earth is distributed through all parts of the circuit, and we are fortunate indeed if the lightning arresters on the line will carry the discharge to earth and prevent any of it going through the machinery. In some cases of an excessively heavy direct discharge, practically all of the apparatus on the line has been burned out, notwithstanding the most efficient equipment of lightning arresters. With the induced discharge, however, we are better able to deal and the remarks in this paper refer almost exclusively to handling such discharges. This induced static electricity is builded up on a circuit by many causes, and while they occur with greatest frequency and intensity during thunderstorms, an electric circuit is never free from them, as they seem to occur under all kinds of atmospheric conditions, often happening when there is no cloud in sight or any other indication of a storm. These induced discharges seem to be caused by the approach of a charged cloud; sometimes by direct discharge from one cloud to another, or from cloud to earth in the vicinity of overhead wires. In some cases they have been known to be caused by a discharge to some adjacent conductor, such as a discharge to the rails of a railway track or semi-insulated conducting surface.

Many, no doubt, have witnessed the operation of lightning arresters in the apparent absence of any atmospheric disturbance. From these facts it is apparent that whatever means of lightning protection is adopted it must at all times be in readiness for operation.

Many, doubtless, feel secure from lightning during certain months of the year and do not give the attention to your lightning arresters that you should. This is not good practice for the very reason just mentioned that these discharges are liable to occur at any time.

In the past it was the practice to install lightning arresters at the station, one being provided for each side of the circuit for the protection of the dynamo. Later on it became the practice to install arresters along the lines, and it was found by this means that less trouble was experienced at the station, while now it is rapidly becoming the practice to install a large number of pole arresters. The object of this is to provide enough outlets on the line, so that there will be no tendency for the lightning to go through the apparatus. In order to secure this result it is of prime importance that the lightning arrester and its ground connection be of the lowest possible resistance. Kicking or choke coils are also part of the standard equipment at the station, one or more being installed on each side of the circuit between the dynamo and the arresters. The inductive resistance of a well-designed coil tends to choke back the discharge, driving it through the arrester. The value of such coils is questioned by many competent engineers, but experience seems to prove their merit, as there have been many cases within my personal experience where standard makes of lightning arresters failed to give the desired protection, until kicking coils were installed. After this no further trouble was had.

It has been contended that only inductive resistance, such as a coil of wire, impedes a discharge of lightning, but close observation has demonstrated the fact that ohmic resistance likewise tends to choke back a discharge.

The effect of inductive resistance is well illustrated by the burning out of a dynamo, in which case the lightning, rather than go through the coils of a dynamo or motor, punctures the insulation and goes directly to ground. It is therefore evident that if the path through a lightning arrester or its connecting wires contains any inductive resistance, the tendency is for the discharge to go through some other path.

The action of ohmic resistance on a discharge is not so easily explained or described. An analogy may be drawn, however, to show that there are two kinds of ohmic resistance, one being the ohmic resistance of an air-gap which is infinite until it is broken down, but does not choke back the discharge as much as the ohmic resistance of a piece of some conducting material, such, for instance, as charcoal, carbon or graphite which remains unchanged after the passage of a discharge. The puncture of the ohmic resistance of an air-gap by a discharge may be likened to the swinging of a pendulum in whose path has been placed an empty glass tank. When the weight on the pendulum strikes the glass wall of the tank, breaking same, it swings on in its path, but slightly retarded. Now the passage of a discharge through a conducting resistance, such as charred wood or carbon, may be likened to the swinging of a pendulum with a glass tank in its path and the glass tank filled with water, in which event the pendulum breaks the wall of the tank and then has the resistance of the water to impede its progress. This is rather a poor analogy, but it has been used before and seems to be satisfactory. Such resistance materials as mentioned are used in many forms of lightning arresters on the market to-day, for the purpose of forming a non-inductive shunt for the lightning around the operating magnet, or to limit the flow of normal current that follows the discharge. In some types such resistance is used to prevent altogether the flow of normal current after a discharge has passed. The use of ohmic resistance for these purposes seems to have a tendency to choke back the lightning, and, if it is employed, it should be kept at the lowest possible limit that will prevent a dead short-circuit of the normal current at the instant of discharge.

Another feature that helps determine the efficiency of a lightning arrester is the air-gap employed in all forms at present on the market. It stands to reason that the smaller the air-gap, other features being equal, the less resistance is offered the discharge. This may be illustrated by the insulation of a dynamo. We will say that this is one-sixteenth of an inch, while the air-gap of a lightning arrester protecting the dynamo is one-thirty-second of an inch. If all other influences are equal, almost all the lightning will always go through the arrester, while if there is another arrester with an air-gap of one-fiftieth of an inch

[1] A paper read before the second annual meeting of the Colorado Electric Light, Power and Railway Association, Colorado Springs, September 21, 22, 23, 1904.

alongside the arrester with the one-thirty-second-inch air-gap and all the conditions are equal, the arrester with the smaller air-gap will easily take the larger part of the discharge.

From the foregoing facts it will be realized that in purchasing and installing lightning arresters you should consider the following points: first, the discharge path through the arrester should be as straight as possible to avoid inductive resistance; second, the ohmic resistance of the arrester, between line and ground binding-post, aside from the air-gap, should be kept at a minimum; third, the air-gap should be as small as possible, but still large enough to prevent the normal voltage of the line jumping it, and to avoid the space being closed by the heating of the terminals during operation; fourth, the ground connection should be such as to ensure a path to damp soil at all times; fifth, the connecting wires should be straight and free from unnecessary turns. In many cases a careful lineman will put a curl in both the line and ground connections to improve the appearance of his job, not knowing that such a coil puts an inductive resistance in the discharge path that may overcome and certainly will impair the efficiency of the installation.

We have noticed that during a storm, or when a circuit is charged with static electricity, it is very rarely that we have a bolt of lightning strike directly the overhead wires. In such a case it would be possible that such a discharge would be localized, that is to say, it might strike the wire at one point, follow it two or three blocks and pass through some outlet, thus following a certain definite path. In the majority of cases, however, this static electricty we have to contend with is builded up on the circuit by induction, and each and every part of the overhead system is charged to a certain static potential. This is constantly escaping or filtering through the different apparatus on the line to earth. Suddenly a heavy discharge takes place in the neighborhood of these wires and the induced potential on them is instantly increased many fold. This surplus static electricity has to find a way to earth, and experience has proven that a certain number of efficient arresters will, under most circumstances, provide a sufficient number of outlets that there will be no tendency for the lightning to go to earth through any other path.

Now, as we have no means of determining in what storm an extremely heavy discharge may occur, it will doubtless appeal to you as good practice to install as many arresters as the conditions will afford. The more outlets you have on the line, the fewer discharges will come to your station and fewer discharges will go through the apparatus on your line. Money invested in lightning arresters is, strictly speaking, an investment. Of course you have a certain amount of expense in keeping them up, but you will find that the larger the number of arresters you have on your circuits the longer will be their average life. This is evidenced by the fact that the fewer arresters connected with the circuit the more each one will have to do, that is, the more times it will be operated, and as they are handling such a tremendous force, it stands to reason that the less work they have to do, the longer they will last.

I feel sure that the points to which I have directed your attention will well repay your careful consideration, but I realize that it is not within the scope of a paper of this character to cover the ground as thoroughly as the subject deserves, and I would suggest that any of the members present that have had uncertain results from their lightning protection state the facts of the case before this convention.

I thank you very much for the opportunity of meeting with you in this way, and hope that any discussion of this matter will be entirely informal.

Higher Scientific Education.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In connection with the proposed combination of the Massachusetts Institute of Technology with Harvard University, the following authoritative statement of foreign opinion (translated from *Zeitschrift des Vereines deutscher Ingenieure* of September 24, 1904) is of interest:

"At a meeting of the Union of German Engineers, held at Munich, September 12, with the participation of thirty eminent representatives of technological schools and universities, as well as of other schools and of industries, the following resolutions were adopted:

"1. It is not advisable, so far as can be foreseen, to attempt to meet the need of new technological schools by the addition of technological faculties to universities, but rather by the establishment of independent institutions; for the technological schools would be hindered in their independent development by attaching them to universities. This separation should not, however, impede the welcome development of intellectual good will between the two institutions. The attachment to universities would also in no way involve economies of consequence.

"2. The Union of German Engineers stands now, as before, by its expression of 1886, as follows:

" 'We declare that the German engineers have the same needs and will be subjected to the same judgment as to their general culture as the representatives of other professions based on higher scientific education.'

"In this view we rejoice as the conviction more and more gains ground that a considerably greater significance is to be attributed than before to mathematical and natural science as a means of culture. Knowledge of these branches is becoming more and more an indispensable constituent of general education. The predominantly linguistic education now received by the majority of our gymnasium graduates does not satisfy the demands which must be made on the leading classes of our people, in particular, in respect to the increasing significance of economic questions."

TECH GRADUATE.

Boston, December 17.

Result of Municipal Lighting in the City of Holyoke, Mass.

It is now two years since the city of Holyoke, Mass., started to make and sell its own electricity and gas. The first year of municipal operation, which ended on December 15, 1903, apparently did not show any decided advantage over the system of private operation. For the first sixteen and one-half months of city ownership, gas was sold at $1.35 net per thousand cubic feet. The first year showed a total profit from both plants of $7,000. The current year, ending December 15, 1904, is expected to show a profit on both plants of at least $31,000, the price of both gas and electricity having been reduced. The price of gas was reduced on May 1, 1904, from $1.35 to $1.20 net per thousand cubic feet.

The city is the largest consumer of electricity. There are 263 arc lights in use, for each of which the board of public works pays the gas and electric department $100 a year. A large amount of gas is also used in the public buildings.

About 380 individual consumers use electricity, and about 5,000 individual consumers use gas in the city. The cost of manufacturing gas is about $1.18 per thousand cubic feet, and it is sold at $1.20 per thousand cubic feet. The laws of Massachusetts require that no municipal plant shall sell gas or electricity for less than the cost of making or generating. Another state law also provides that five per cent depreciation is to be charged against the operating expenses. If it were not for this, the cost of making gas would be much lower than $1.18 per thousand cubic feet, and the gas could be supplied at a much lower rate than it now is.

THE NOVEL FEATURES OF THE WESTINGHOUSE EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

BY EDGAR S. DOWNS.

Probably no place affords such facilities for studying the advances made in the arts and sciences as an international exposition. The best from all the world is here brought together, affording unequalled opportunities for comparison and making it possible to obtain a survey of any particular field, not to be secured in any other manner. The man who has devoted his lifework to the solution of some special problem can add to his knowledge from the accomplishments of others and secure a new impetus and added courage for the future.

In the field of engineering, especially that of electrical engineering, progress has been most marked and rapid. The great problems arising from the necessity of the economic production and distribution of large amounts of power, better facilities for transportation and cheaper and better methods of lighting have led many of the greatest minds to devote their best powers to their solution. It is but natural that most rapid progress should have taken place along these lines.

It is a significant fact illustrating the tendency of the age that the largest individual exhibit at the Louisiana Purchase Exposition—that of the Westinghouse companies—had its origin in the solution of these problems.

In the Westinghouse exhibits in the palaces of machinery, electricity and transportation were a number of radical innovations in the fields of mechanical art and electric lighting, although most of the space was occupied with the display of electric generating units and auxiliary electrical apparatus, the greater part of this having to do with improvements upon that already in use. Among these innovations are the steam turbine, the horizontal, double-acting gas engine, the single-phase, alternating-current railway motor and the Cooper Hewitt mercury vapor lamp, all of which will be taken up in detail.

The most striking features of each exhibit will be dealt with, starting with that in Machinery Hall. In an article of this kind the service plant for the exposition—designed and installed by Westinghouse, Church, Kerr & Company, deserves mention, principally because it represents the best modern practice and also because of its completeness. It is of 14,000 horsepower, consisting of four 3,500-horsepower, vertical cross-compound, reciprocating engines, built by the Westinghouse Machine Company, running at a speed of eighty-three and one-third revolutions per minute. The electric generators are of 2,000-kilowatts capacity, two having been built by the Westinghouse Electric and Manufacturing Company, and two of similar design by the General Electric Company. They are of the engine-type, revolving field construction, being mounted between the cylinders of the engine, and generate three-phase current at a frequency of twenty-five cycles and 6,600 volts. The engines were installed side by side at the same distance apart, making a compact arrangement with this type of engine, and economizing space. Three eighty-kilowatt, 125-volt Westinghouse engine-type units supplied the direct current for exciting the fields of the large alternators. The size of the units, 3,500 horse-power, was determined both by the nature of the load at the exposition and by the fact that they must be sold at its close. During the day, until 3 P. M., the load varied from 2,100 to 4,200 kilowatts, which could be economically supplied with two engines in operation. The load increased to about 5,500 kilowatts at 3 P. M., when the current for the lighting and power required by the Pike shows was added, necessitating the starting of a third engine. The plant was also called upon to furnish power for the motors driving the pumps which supplied the water for the cascades from 4.30 to 5.30 P. M., and also from 6.30 to 9.00 P. M. daily. About 1,600 kilowatts additional current was required for this work, which was supplied by operating all four units at once. Again, in case of accident to one of the units the requirements could easily be met by carrying an overload on the other three, when necessary. The demand for units of this size is much greater than for those of larger capacity, making it an easy matter to dispose of them under ordinary conditions.

The presssure, 6,600 volts at the generators, was well adapted for the service at the exposition, the distances of transmission not being over two or three miles to the distributing points, where the transformers were located. It would also be well adapted for service in another installation. Allowing for a ten per cent drop in the voltage in transmission 6,000 volts is a pressure much used in transformer design at present, making it well suited for many transformers already in use.

The method of operating these large generators in multiple was most successful. For this reason it is of interest, and also because it made it possible to control them from the switchboard. A small motor was provided at the engine for moving an adjustable weight on the governor mechanism. With this motor controlled from the switchboard the speed of the engine could be adjusted until the incoming generator had been synchronized and connected to the system. There was an automatic speed limit upon each engine which closed the throttle valve instantly in case the safe speed should be exceeded because of accident to the governor mechanism.

A twenty-nine panel marble switchboard was used for controlling the current. It was equipped with electrically operated oil switches behind the operating panels, and with high-tension oil immersed automatic circuit-breakers, recently developed by the Westinghouse Electric and Manufacturing Company. Remote control of the current was exclusively employed, doing away with all danger to the switchboard attendants. The oil circuit-breakers were installed behind the switchboard in masonry in the manner which is being quite generally adopted at present.

Steam for operating these engines was supplied from boilers located in the Steam and Fuels Building, just west of the Palace of Machinery. Roney mechanical stokers—a comparatively recent product of the Westinghouse Machine Company—were employed for firing the boilers. The production of smoke, which was discountenanced upon the exposition grounds, was reduced to a minimum, very little smoke having been perceptible from the time the plant was started. All the engines operated condensing, two condensing equipments, each of 7,000 horse-power, having been installed for this purpose, each equipment being used for two of the large engines. The water for the condensers was passed through cooling towers and used again.

The two most striking features of the exhibit in the Machinery Building were the Westinghouse-Parsons steam turbine and the horizontal, double-acting gas engine. A steam turbine was seen in operation here for the first time at a world's fair. The 600-horse-power steam turbine in the exhibit, which is shown in Fig. 2, was in operation continuously, night and day, from June 20 until the close of the exposition, Dec. 1. It operated at a steam pressure of 150 pounds and a vacuum of from twenty-seven to twenty-eight inches, running at a speed of 3,600 revolutions per minute. The absence of vibration in the turbine made it possible to construct a very simple foundation,

consisting merely of ten-inch steel beams, under which the complete condensing outfit was located.

The turbo-generator of the revolving type had a rated capacity of 400 kilowatts. It delivered a sixty-cycle, three-phase alternating current, at 440 volts and 7,200 alternations, used for lighting and various operating exhibits in the Westinghouse spaces in the palaces of machinery, electricity and transportation, rotary converters and static transformers being located in appropriate places, to change it to the necessary form. Some very large 8,000-horse-power Westinghouse-Parsons turbine units have recently been ordered for installations in New York and Philadelphia, showing the rapid change taking place in the methods of production of large amounts of power.

The internal combustion engine has now been developed to a stage in which it is well adapted for driving large electric generators. The fuel which it consumes is used in the cylinders, making possible a higher fuel efficiency than that of any other known type of prime mover. It possesses features which indicate that it will be very generally adopted for various power purposes in the future. In Europe, where fuel is relatively more expensive than in this country, engineers have devoted a great deal of attention to its development. During the past few years considerable work has been done upon it in this country, resulting in the production of engines well adapted for large installations.

The 225-horse-power gas engine exhibited has two cylinders arranged in tandem with a common piston rod and operates at a speed of 200 revolutions per minute. The engine is double-acting, explosions taking place in both ends of the cylinders. A power impulse is given at each forward and backward stroke, bringing about conditions similar to those which prevail with the steam engine and doing away with the large and cumbersome flywheels ordinarily used for steadying the speed of gas engines. These engines are built in sizes up to 6,000 horse-power and are well adapted for driving large alternating-current dynamos. The gas engine on exhibit was used to drive a 100-kilowatt direct-current generator, supplying current to a three-wire system, having 125 volts between the neutral and each of the outside wires.

The artistic features of the exhibit in the Palace of Machinery must not be omitted in this brief description. It was enclosed in walls of a classic architecture of great beauty. Along the north side was a row of booths, each one bearing the name of a foreign country in which some Westinghouse interest is located, and being appropriately decorated with the national colors of that country. All were furnished very completely for the reception of guests.

The front of the auditorium, another important feature of the exhibit, formed a part of the wall along the east side, and added to its effect. The interior of this auditorium, finished in white, impressed all with the beauty of its design. In the centre was a large dome, in which had been placed Cooper Hewitt mercury vapor lamps, Nernst lamps, a Bremer arc lamp and incandescent lamps, making possible some wondrously beautiful lighting effects. The auditorium seated comfortably 350 people. Three exhibitions of moving pictures, accompanied by a descriptive lecture, were given daily at 10.30 A. M., and 2.30 P. M. and 4.30 P. M. These pictures represented scenes in and about the Westinghouse works located in and near East Pittsburg, Pa. A number of them were unique in that they represented interior views showing the processes of manufacture, which were made possible only by the light from the Cooper Hewitt mercury vapor lamp. So clearly were these scenes depicted that to attend an exhibition was almost equal to a visit to the plants themselves, making them extremely interesting and instructive and at the same time very entertaining.

The attendance at the exhibitions was large, showing that their merit was appreciated. A new field in publicity and education has been opened to the biograph by the discovery of the mercury vapor lamp and its adaptibility for photographic purposes.

The lamps exhibited which represent the most material advances in the art of electric lighting were the Cooper Hewitt mercury vapor lamp and the Bremer arc lamp. The Cooper Hewitt lamp possesses features which indicate that it is the preliminary of a new era in the history of electric lighting. It has a remarkably high efficiency and is one of the richest known lamps in its actinic properties, being therefore especially well adapted for photographic purposes.

The Bremer arc lamp is novel in its high efficiency and in the color of its light. The carbons have been placed at an acute angle with each other to avoid casting a large shadow. They have been dipped in different chemical solutions to change the color of the light and make it richer in red rays. The lamp is operated upon a low-voltage direct-current circuit.

The Nernst lamps, first shown at the Pan-American Exposition in Buffalo, were used where a pure white light was needed. They are designed to run upon alternating-current circuits and have a high efficiency, emitting light very near in color to that of sunlight and therefore especially well adapted for showing color effects. A very complete line of alternating-current and direct-current arc lamps, recently developed, was displayed in the Palace of Electricity, among which were some multiple arc lamps designed for use upon 110-volt circuits. The incandescent lamps, manufactured by the Sawyer-Man Electric Company, a Westinghouse interest, were employed extensively for lighting the different exhibits.

The transformation in the methods of transmitting power to the different parts of a factory now taking place so rapidly, was well illustrated in the exhibit of machine tools at the west side of the space in the Machinery Building. These were driven by Westinghouse alternating and direct-current motors. A representative of the common types of machine tools, such as boring mills, drill presses, lathes, etc., used in machine shops and for manufacturing purposes, was here exhibited in operation.

The two most novel features of the exhibits in the Palace of Electricity were the 400-kilowatt, turbo-generator and the single-phase alternating-current, series railway motor, the greater part of the space containing types—most of them recently improved designs—of nearly all the lines of apparatus manufactured by the Westinghouse Electric and Manufacturing Company. The high speed of the turbine makes it possible to build a much smaller electric generator for a given output than has been practical with the slower speed reciprocating engine. The bi-polar rotating field had been removed from the stationary armature of the turbo-generator to show the method of construction, which is interesting. It consists roughly of a cylinder of nickel steel, in which slots have been milled for the reception of the winding of copper strap carrying the magnetizing current. Other slots have also been made perpendicular to those containing the winding, for purposes of ventilation. Grooves are cut along the inner edge of the slots, in which wedges have been driven to hold in position the turns of copper strap. After the wedges have been put in place the edges outside the cylinder of steel are removed in a lathe, making the cylinder round and smooth, none of the winding being perceptible upon the outside. The peculiar design of the sta-

tionary armature was adopted because of the necessity of the dissipation of the large amount of heat developed while in operation. The cast-iron yoke is a mere shell containing numerous holes for the admission of air. A large space has been left between the outside of the sheets of soft steel carrying the magnetic flux, and the inside of the yoke, to permit the air to circulate freely and keep the temperature below the danger point.

The single-phase alternating-current series railway motor—it is believed—represents a distinct advance in the solution of traction problems. It has long been recognized that if a successful alternating-current railway motor could be devised it would lend a great impetus to the installation of electricity upon lines now operated by steam locomotives. The static transformer only would be needed to change the current to the necessary form, doing away with the rotary converter. In appearance the motors exhibited are not unlike the ordinary direct-current railway motors. They have very much the same shape, and the familiar commutator is also in evidence. A truck, equipped with two seventy-five-horse-power motors, designed to run at a potential of 225 volts was shown in operation. A considerable number of these motors are now being built for service upon different equipments. Some single-phase alternating-current crane motors, similar in design to the railway motors, were also displayed.

The unit switch system of multiple train control was employed to operate two 200-horse-power railway motors upon a truck. The system is electropneumatic in its operation, the current being supplied from storage batteries upon the cars and the air from that used for the air brakes. Current at a potential of fourteen volts is sufficient to operate it. The independent or unit switches controlling the current supplied to the motors of the car are grouped together about a central air reservoir, and are operated by small pneumatic cylinders, the valves of which are controlled by electromagnets. These are in turn energized by current passing through the motorman's controller. This extremely compact arrangement makes possible the use of a single magnetic blow-out coil for the entire group. The magnet valves controlling the unit switches are so connected by mechanical interlock switches that the closing of one energizes the magnet of the switch next succeeding. A limit switch is used to regulate this automatic progressive action thus produced, which is so adjusted that the various switches are closed in succession affording a uniform acceleration with a constant motor current, the rate of this acceleration being determined by the adjustment of the limit switch and independent of the personal characteristics of the motorman.

The exhibits of the different types of electrical apparatus being manufactured at present were remarkably complete, among which the following deserve mention: a line of direct-current power motors with the bearings resting upon the end brackets, making a compact design; some constant current arc light regulators both air-cooled and oil-immersed types; a number of large oil circuit-breakers for voltages varying from 22,000 to 60,000, designed to meet the requirements of the high potential used at present upon the long-distance transmission lines; an entirely new line of portable measuring instruments, some alternating-current generators of the revolving type, varying in sizes from 100 to 150 kilowatts, a number of oil-immersed transformers, representing the latest development in transformer work; controllers for variable speed direct-current motors with the resistances beneath them, making the whole remarkably compact; single-phase induction type constant speed power motors, built in small sizes.

It is a noteworthy fact, illustrating the progress achieved in the application of power brakes upon electric cars, that about half the space in the Palace of Transportation, which was devoted to the exhibits of the different products of the Westinghouse Brake companies, was occupied by the products of the Westinghouse Traction Brake Company. The magnetic traction brake and car-heating apparatus, recently developed, was shown. A truck equipped with this brake was operated upon a track forty-five feet long, in connection with which was a separate brake controller used when the magnetic brake is put upon a car having an ordinary controller for its motors. A controller designed for operating both the brake and the motors has also been developed.

The advantageous features of this brake have been well tested upon cars equipped in this country and in Europe during the past three years. It has been found especially well adapted for service upon railways having excessively steep grades. In such places the combination of brake and car heater makes it possible to operate the brake and heat the cars without the expenditure of any line current, the power being produced by the motors running as generators while the brakes are in operation. This results in a saving sufficient to pay for the brake equipment within a short time. A device for regulating the voltage of the current so generated, and keeping it below the limit of injury to the insulation of the motors by inserting resistance automatically in the field circuits, has been developed recently.

The air-brake equipments for electric cars were illustrated in the steam railroad apparatus of the Westinghouse Air Brake Company. Upon all cars operated wholly or occassionally in trains of quick action automatic brake is strongly recommended. This was exhibited upon a completely connected equipment for a six-car train.

The new automatic air and steam coupler attracted much favorable attention among railroad men. With this device the air and steam pipes between the cars of a train are coupled automatically when the cars come together. The two metal parts containing the ends of the pipes interlock in such a manner that the wear upon the connections is reduced to an almost negligible quantity to say nothing of the convenience in coupling the cars.

The three Westinghouse motors used for driving the centrifugal Worthington pumps which supplied the water for the cascades were of interest because of their size. The motors were rated at 2,000 horsepower each, and were said to be the largest in the world. They were of the variable-speed induction type, the primaries being wound for a three-phase current at 6,000 volts, 3,000 alternations per minute and a speed of 365 revolutions per minute. The design was similar to that of the ordinary variable-speed, induction-type, alternating-current motor, built by the Westinghouse Electric and Manufacturing Company. A hand controller, having fifty-four steps, was employed for operating the grid resistances connected through the collector rings with the secondary. The motors were operated throughout the exposition with eminent satisfaction.

The New York Electrical Trades Society.

At the annual meeting of the New York Electrical Trades Society, held at the Hotel Astor, New York city, December 13, the following officers were elected: president, John H. Dale; vice-president, H. R. Swartz, Sprague Electric Company. Directors: G. E. Pingree, assistant treasurer, Western Electric Company; B. H. Ellis, assistant treasurer, Manhattan Electrical Supply Company; R. B. Corey, manufacturers' agent; A. S. DeVeau, manufacturer of telephones; C. C. Sibley, of Sibley & Pitman.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Improved Blue-Printing Machine.

The Pittsburg Blue-Printing Company, suite 1505-J, Park Building, Pittsburg, Pa., has recently improved its electric blue-printing machine, which in its present form is a highly perfect piece of apparatus. Two truly curved semi-cylindrical glass plates are separated along their longitudinal edges by wooden strips and the whole is rigidly bound together by brass bands, top and bottom, to form a cylinder. Canvas covers are attached to the back strip and are drawn tight by means of spring clips which fasten over a brass rod on the front strip. (Fig. 1.)

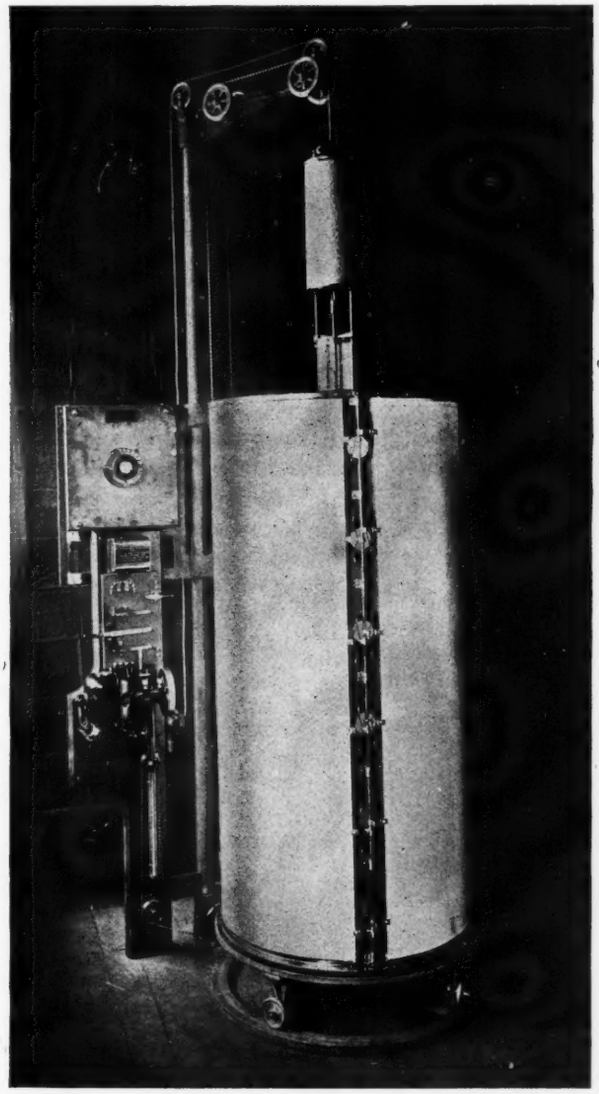


FIG. 1.—ELECTRICAL BLUE-PRINTING MACHINE.

The cylinder is supported on a trunnioned cast-iron base, arranged to allow of the cylinder being tilted in order to facilitate loading and unloading.

The lamp bracket is carried by an upright wrought-iron mast to which are also attached brackets for supporting the auto-gear or automatic lamp controller, lamp resistances, switches, etc. This mast is fitted into a boss on the cast-iron base-plate and is held rigidly by set screws. The brackets are held in proper position on the mast by steel pins and the whole forms a rigid, compact structure. This machine, being entirely self-contained and independent of wall connection, can be set in any part of a room desired and can be easily moved from place to place.

An automatic lamp controller has been added, which combines the utmost simplicity of construction and operation, with all the automatic features obtainable in the older forms.

This device shown in Fig. 2 consists essentially of the small electric motor, which both controls the speed of the lamp in lowering and raises it to the starting position. The motor is started by raising the main switch until the blades are in contact with the upper switch jaws. The motion of the motor is transmitted through worm and gear to the long vertical screw, and this, in turn, causes the nut bearing the sheave wheel to travel down. This nut is connected with the lamp by the brass chain shown leading to the right in this cut. When the nut has descended to the point corresponding to the lowest desired position of the lamp,

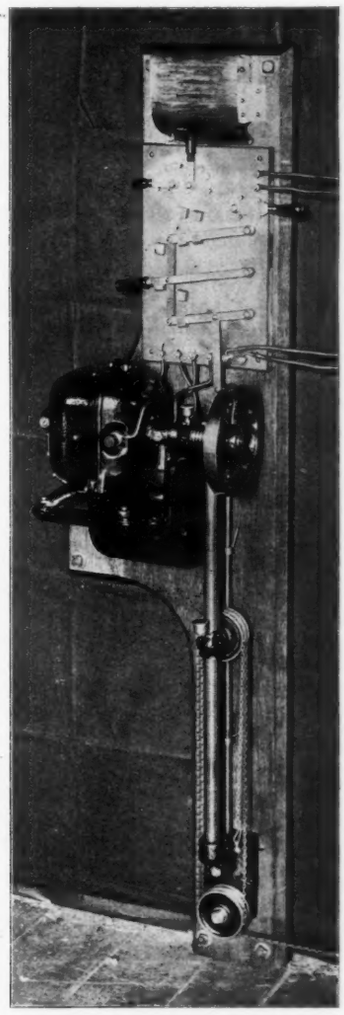


FIG. 2.—CONTROLLING APPARATUS FOR BLUE-PRINTING MACHINE.

it strikes the lower collar of the switch stem, thus throwing the switch over to the lower switch jaws and reversing the motor. The nut then travels up the screw until the lamp has reached the highest point desired, when the nut strikes the upper collar of the switch stem, and raises the switch blade to a position midway between the two sets of contact, thus stopping the motor. The speed of the lamp descending is controlled by one of the rheostat handles seen in the upper left-hand corner of the switchboard, while the other rheostat handle controls the speed of the lamp going up.

The single blade switch on the right-hand side of the switchboard is used for regulating the light as follows: if the switch rests on the upper contact button, the lamp is automatically lighted when it starts to descend and automatically cut out when it reaches the bottom.

If the switch rests on the lower contact button, the lamp is lighted when it starts up and cut out when it reaches the top. If the switch blade is in contact with both contact buttons, as shown in the cut, the light is automatically lighted when it starts to descend and cut out when it reaches the top.

The range of travel of the lamp can be adjusted by moving the collars on the switch stem to position corresponding to the highest and lowest points that it is desired for the lamp to reach.

It will thus be seen that the working of the whole apparatus is entirely automatic. After the operator has closed his switch to start the apparatus subsequent operations are all gone through without any attention from him whatever.

In operation, the tracings and sensitized paper are placed around the glass cylinder and the canvas curtain drawn tight to hold them in place and give proper contact. The lamp switch is then closed and the variable lamp resistance adjusted to give the arc the maximum printing effect.

Incandescent Lamp Tests.

The Germania Electric Lamp Company, Harrison, N. J., has announced a report of tests on incandescent lamps of its production made by the Bureau of Standards of the Department of Commerce and Labor at Washington, D. C. Part of this report is as follows:

The value of the standards of the bureau is known in Hefner units, but the above results are expressed in terms of the English parliamentary candle, in the relation accepted by the American Institute of Electrical Engineers between the Hefner unit and the English parliamentary candle, one Hefner = 0.88 candle.

The value found for the lamps submitted by your company were as follows:

		Candle-Power.	
	Volts.	Stated.	Observed.
No. 2.....	109.3	16	15.90
No. 4.....	109.5	16	15.85

Storage Batteries for Stationary and Vehicle Work.

The New England Motor Company,

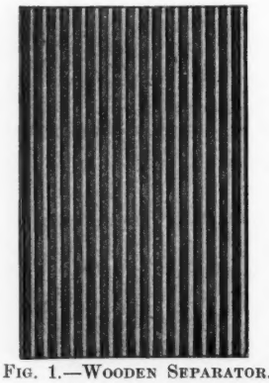


FIG. 1.—WOODEN SEPARATOR.

Lowell, Mass., is manufacturing a complete line of storage batteries for stationary or vehicle work. The details of this

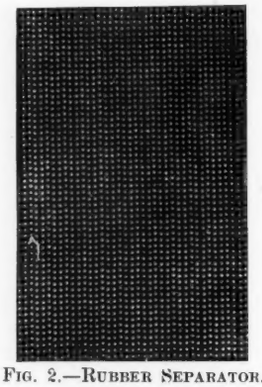


FIG. 2.—RUBBER SEPARATOR.

apparatus have been carefully worked out. The company also manufactures a line of small, portable batteries for ignition

FIG. 3.—NEGATIVE PLATE.

purposes, or for running phonographs and other light apparatus.

The batteries are of the pasted type, the active material being applied to grids. The negative plates are formed of practically pure lead, and the positive grids are formed of an unoxidizable alloy.

Wooden separators (shown in Fig. 1) and rubber separators (shown in Fig. 2) are used. The wood is treated by a special process to prevent the formation of acetic acid or gum dextrin during subsequent operation of the battery. The negative

FIG. 4.—POSITIVE PLATE.

paste consists of litharge and dilute sulphuric acid, applied in the usual manner.

Fig. 3 shows the negative plate after formation. The positive plate, however, is of a secret composition, and the manufacturer claims for it that, while it possesses all the porosity which it is possible to obtain by any method of pasting, still the peroxide which is obtained by this method is of much greater hardness and shows less tendency toward disinte-

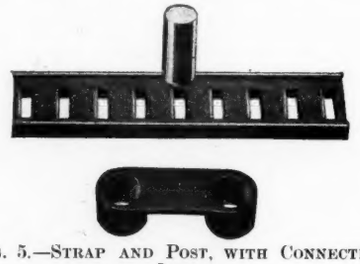


FIG. 5.—STRAP AND POST, WITH CONNECTING LINK.

gration or powdering in the cell than is obtainable by any other process.

This result, the company states, has been attained only after years of rigid experimentation. The company claims a longer life and greater output per pound of complete cell because of this peculiarity of the positive plates.

New positive plates will be furnished by the company. They are shown in Fig. 4. These plates may be used with any standard types of battery. This will allow the consumer to bring up the capacity

of a battery which may have fallen off, due to deteriorated plates.

Fig. 5 shows the strap with its post, and the connecting link.

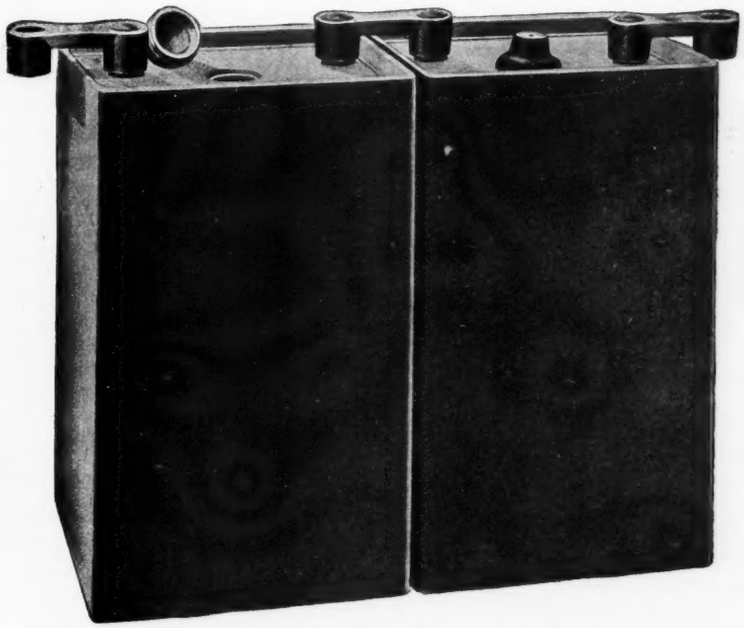


FIG. 6.—TWO COMPLETE CELLS OF 150-AMPERE-HOUR CAPACITY.

Fig. 6 shows two complete cells of 150-ampere-hour size, assembled and burned together. Care is taken that no dissimilar metal is used in forming the joint. The positive straps are made of the same alloy as the positive plates, and in burning the positive plates to the straps the metal of the same alloy is used. This eliminates electrolysis at the joint.

The Bogia Regulating Socket.

Louis F. Bogia, 146 North Seventh street, Philadelphia, Pa., has recently invented and placed upon the market a new regulating socket for incandescent lamps. Any of the commercial types of incandescent electric lamps can be used with these sockets and receptacles. The candle-power may be dimmed from full capacity down to darkness, and a considerable saving of current is effected when a lamp is dimmed. The reduction is accomplished gradually, the candle-power not being reduced in step divisions, but is accomplished by simply turning the key in the holder, which will raise or lower the incandescence of the lamp filament until the exact amount of light desired is obtained.

No combustible material enters into the construction of the socket, and the holders are absolutely fireproof. The resistance material is embedded in porcelain, but any other suitable refractory material may be used if desired.

One type of holder will dim four, eight or sixteen-candle-power lamps with 110-volt, constant-potential circuits, and another type will dim the same candle-power lamps with 220-volt circuits. They may be used also to reduce the speed of portable fan motors and to regulate small electric-heating apparatus, etc. The holders resemble the regular type of

BOGIA REGULATING SOCKET.

socket, and have practically the same size. No special base is required on the lamps, and no intricate method of wiring is necessary.

Telephone Apparatus Manufactured by the Vought-Berger Company.

The Vought-Berger Company, of La Crosse, Wis., is calling attention to the line of telephone apparatus manufactured by it. This apparatus includes everything from a complete switchboard down to the smallest appliance which is used in telephone work.

One of the pieces of apparatus is the pendent telephone, shown in Fig. 1. This type of telephone is a distinct departure

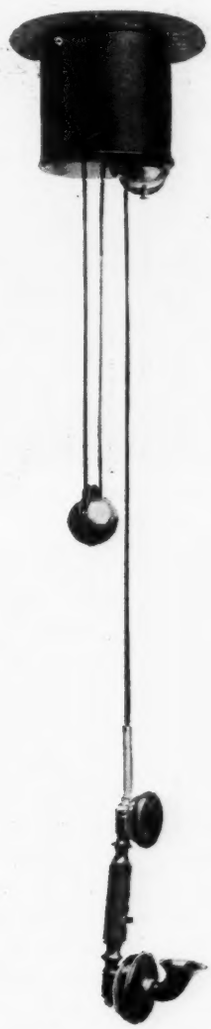


FIG. 1.—PENDENT TELEPHONE.

from anything heretofore on the market, being suspended from the ceiling and taking the place of a desk set or wall telephone. The adjustable cord feature is what gives it its particular value. This admits of the hand telephone being raised or lowered at will. In magneto systems the simple action of lowering the microtelephone signals central if any conversation is desired. Then, by placing the fingers on the small lever in the handle

of the instrument, the calling party is ready to begin conversation. When the conversation is at an end, a light pull on the telephone gives the operator the disconnecting signal.

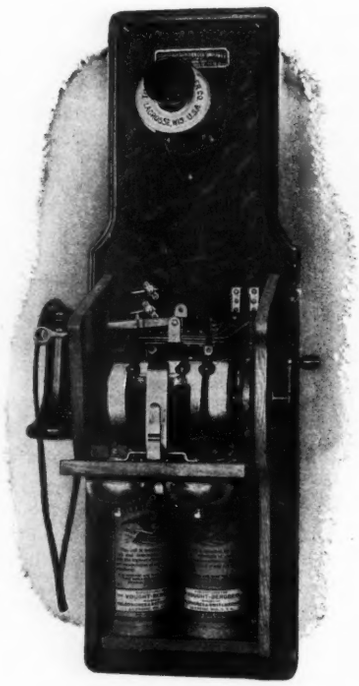


FIG. 2.—NUMBER FORTY-FIVE TELEPHONE

In central energy systems pulling the hand telephone to the position in which it is wanted and pressing the lever, gives the operator the signal. Releasing the lever gives the disconnecting signal. The telephone can then be pushed up out of the way.

One of the annoying features of the adjustable telephones now in use is that while they may be convenient for the person at whose desk they are installed, still if any one else is called to the telephone, there is more or less inconvenience in changing places, and the first party has to give up his desk for the time being. Since the pendent has a vertical adjustable length of fifteen to eighteen feet, it can be passed from the desk over to the other person called, without the slightest inconvenience.

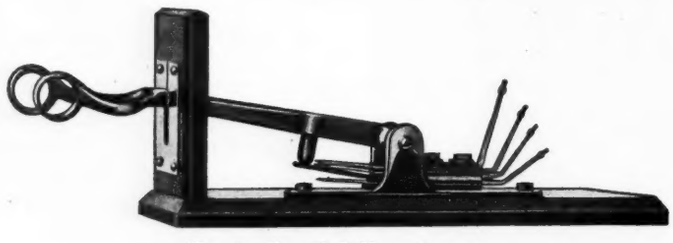


FIG. 3.—THE V-B HOOK SWITCH.

A grooved fibre pulley in the magneto telephone is fastened to the generator in place of the ordinary crank. It is made in such a manner that it will turn the armature in one direction. A small dog engages with a ratchet wheel, so that when the pulley is turned, the armature is rotated. This is done by means of a long flexible cord that is attached to the hand telephone. This cord passes up round the pulley, thence down to the counterweight, which is carried by another fibre pulley; thence around and into a ceiling cabinet where it is fastened. The cord also serves the function of conductors from the magneto portion of the telephone to the hand telephone. The ceiling cabinet is encased in a circular covering of steel or iron, which is decorative and forms a protective cover.

FIG. 4.—LITTLE GEM EXTENSION BELL.

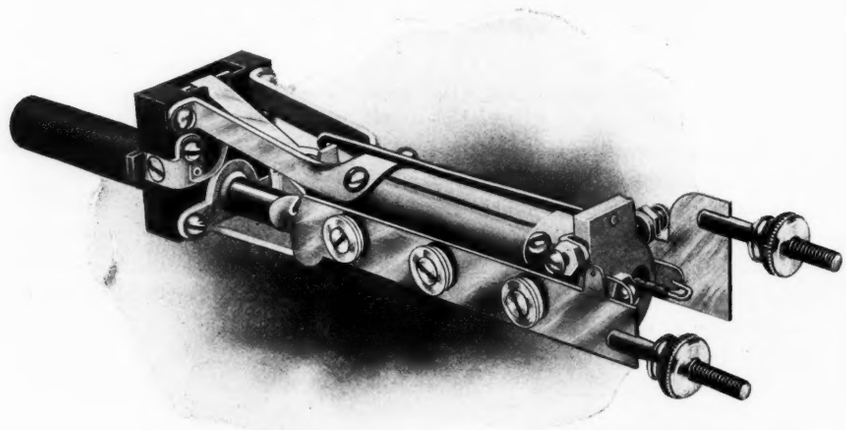


FIG. 5.—V-B EXPRESS DROP AND JACK.

The No. 45 telephone made by this company is claimed to possess all the advantages of the compact style of telephone, with none of its disadvantages. One of its points of superiority is that the receiver and crank are on a level with the arm. The transmitter is on a level with the mouth. It is a sightly telephone, and ornamental in the extreme. The instrument is illustrated in Fig. 2.

These telephones are handsome, durable and efficient. They are especially constructed for heavily loaded lines. The cabinets are of best quarter-sawed oak, thoroughly dried and well finished. The generators are made of tungsten steel, retain their magnetism permanently, and are strong enough to ring as many telephones as can be put on a single line. The transmitter is unusually sensitive. The receiver is so powerful as to reproduce even the slightest whisper on a well-constructed line. The switch-hook, shown in Fig. 3, is entirely self-contained. Its main spring is three-ply, and is made on the wagon-spring principle. It is made of the very best material, hard rubber, German silver, ninety-nine per cent pure platinum and mica. The lever is of the new stamped type. No side springs, rollers or complicated arrangements of any kind are used in the switch-hook. All telephones are equipped with the Columbia dry batteries. The instruments are most carefully assembled, and are thoroughly tested before shipment.

The Little Gem extension bell is shown in Fig. 4. It is covered by a japanned sheath which opens like a cuff. It is accessible in every way. The ringers are easily adjustable. The bell is made up both series and bridged, and is also

equipped for use on central energy lines with condenser in cabinet.

The V-B express drop and jack is shown in Fig. 5. It is small and compact, and when placed in the case is flush; that is, there are no projections sticking out in the front of the drop to catch on the operator's clothing. All drops, both series and bridging, are ironclad and are assembled in drawn Norway iron tubes. The board is made up in individual self-contained drops, each drop being readily removable without disturbing the working of any of the others. There are no wires to solder or unsolder in adding or changing drops. It is very easy to add a new drop and jack, or to change the series to bridging, or *vice versa*. The coil is very large, and is wound with silk-covered copper wire. There are but few moving parts. The drop and jack are absolutely rigid, as all the brackets are made of cold rolled steel. Being removable, the drops are very easily adjusted. The jack springs are large, heavy and strong, and are made of the best grade of German silver. Night bell contacts are so arranged that dust can not injure them or cause them to fail as the shutter in falling forms a sliding contact which at all times is positive and sure. All parts made of iron are either nickel or copper-plated. The front mounting blocks are made of the best grade of hard rubber, which is machined accurately to size, and gives the board a handsome and neat appearance.

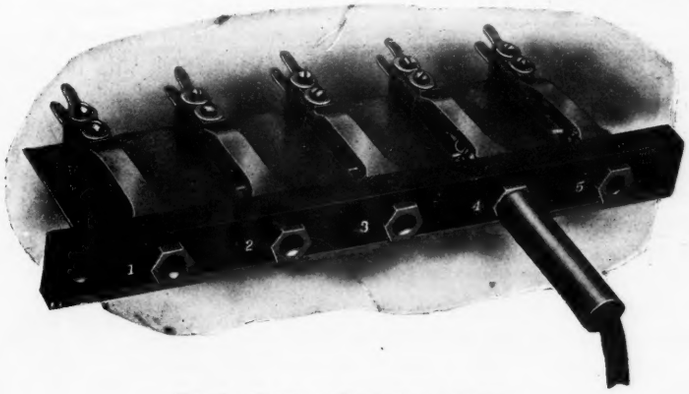


FIG. 6.—BANK OF BELL STYLE JACKS.

The bell-type drops shown in Fig. 6 are tubular, sensitive and non-inductive. They are mounted in banks of five on rigid brass strips. Jacks are also mounted in banks of five. The jack springs are large, heavy and strong, and are made of the best grade of German silver.

A style G-X switchboard is illustrated in Fig. 7. It is a 200-line express board. The board is built of very best, well-seasoned, quarter-sawed oak, of handsome grain and finish. All insulation is made of hard rubber, all springs of best German silver, and all contacts ninety-nine per cent pure platinum. The plug is made of solid bar stock. The fibre sleeve is free to rotate on the plug. This feature does away with the possibility of the operator twisting the cord while the plug is in the jack. Connecting cords have spiral protection.

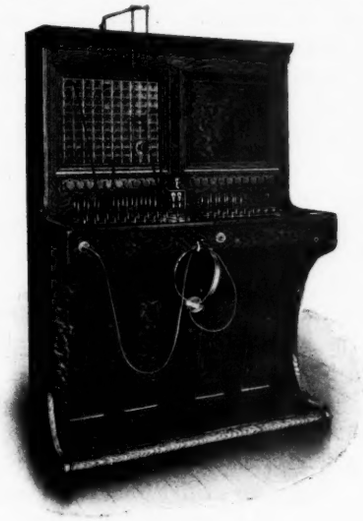


FIG. 7.—STYLE G-X SWITCHBOARD.

The "Pelton" High-Speed Steel Furnace.

Pelton & Crane, Detroit, Mich., are the manufacturers of the "Pelton" electric furnace, adapted for enameling purposes, hardening of steel hubs and dies, and for the purposes of high-speed assays. The furnace can maintain a steady, even heat at any desired temperature, and is absolutely free from dust, noise or odor.

The furnaces are made for pressures of 100 and 120 volts. Either direct or alternating current may be used, and machines may be made for special voltages if desired.

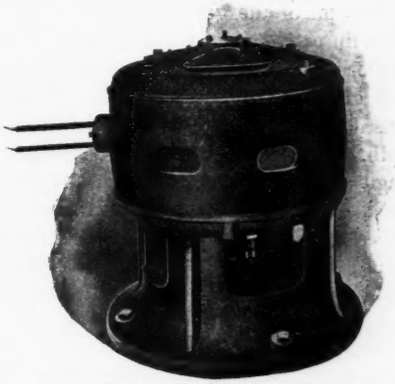
The manufacturers claim that the furnaces are practically indestructible and will not burn out unless subjected to excessive abuse.

A rheostat is furnished with the apparatus which allows the operator to bring the heat up to the required point gradually, and admits of the heat being lowered or raised at will. The controlling lever is in front of the apparatus, where it is most convenient for the operator. The body of the furnace is finished in black enamel. The knife-switch, contact-points, door and hearth are nickel-plated, and the whole is mounted on a base of marble.

A muffle door is furnished, with a large sheet of mica, which affords an unobstructed view of the interior of the muffle. This enables the operator to observe the progress of the work.

Single-Phase, Alternating-Current, Vertical-Type Motors.

The Wagner Electric Manufacturing Company, St. Louis, Mo., has recently added to its line of single-phase, alternating-current power motors a very neat type of vertical single-phase motor. An illustration of this motor appears herewith. The special field of application for such a motor is the driving of centrifugal pumps and work of a similar character.



SINGLE-PHASE, ALTERNATING-CURRENT, VERTICAL-TYPE MOTORS.

In general construction, this motor corresponds electrically to the well-known forms of Wagner single-phase motors already on the market. Mechanical features have been introduced, however, such as ball bearings, etc., which distinguish it from previous types. This results in an excellent efficiency and quiet running of the motor.

The Wagner company is prepared to make immediate deliveries on ten and fifteen horse-power sizes for sixty cycles. The windings are for 110, 220 and 500 volts, and the speed is 1,150 revolutions per minute.

The Polk Guy Anchor.

Robert H. Polk, Memphis, Tenn., has placed on the market a new form of guy anchor for pole line work. At the recent meeting of the Interstate Independent Telephone Association, at Chicago, Ill., Mr. Polk adopted some unique tactics in advertising the Polk anchor. He distributed a large number of Confederate and old state money, bearing on the obverse

POLK GUY ANCHOR, CLOSED.

side the endorsement of the Polk anchor. A model anchor was shown, and the new device was the subject of much commendation.

The accompanying illustrations show the anchor both open and closed.

The anchor is constructed of two scooped blades pivotally attached to a guy rod by a riveted bolt through a clevis on the end of the guy rod. Each blade has a lip extension at the outer end.

In order to install this anchor, a special form of auger, supplied by Robert Polk, is used to bore a hole five or six feet in depth. The wings of the anchor lie snugly alongside of the guy rod, and the folded up anchor is slipped into the hole. The earth is then placed in the hole, tamped and rammed, and then the strain is put upon the anchor. The outwardly

POLK GUY ANCHOR, OPEN.

projecting lips cause the wings of the anchor to spread apart. The dimensions of the hole are such that the wings of the guy anchor take a firm hold in the permanent earth. That portion of the earth which has been displaced by the auger lies very close to the rod and concerns only a small part of the holding surface of the device.

It is claimed by the manufacturer that about fifteen minutes is the average time required for placing a Polk anchor in ordinary earth. Where disintegrated rock or other formation is encountered, the special form of auger makes the installation possible in about thirty minutes.

This anchor is fully covered by patents granted June 14, 1904.

Westinghouse Steam Turbines in New Baltimore Power System.

It has been announced recently that the new Baltimore electric power system will use exclusively steam turbines as prime movers. A contract has been closed with the Westinghouse Machine Company for an initial equipment of 4,000 kilowatts. There will be two units of 2,000 kilowatts each. The electrical equipment is also to be provided by the Westinghouse company.

The power-house will be of fireproof construction, and the structural steel frame will serve as supports for the boilers and the overhead coal bunkers. All the heavy machinery and boilers will be on the ground floor. The floors and roof of the power-house will be of a concrete-steel construction. The company's property is located on Gould street, about two and one-half miles from the centre of the city, and extends to the Patapsco river. It comprises 6.4 acres, and three acres will be added to the area by filling in to the wharf line. This will give sufficient space to enlarge the plant whenever needed. The Baltimore & Ohio and the Wabash railroad systems immediately adjoin the property, and afford ample facilities for securing coal.

The turbine plant will operate with a boiler pressure of about 175 pounds, superheated about 100 degrees Fahrenheit.

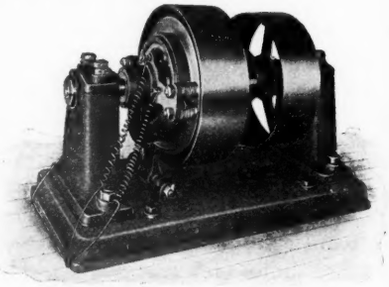
The condenser system will be capable of sustaining a vacuum of twenty-eight inches at full load. The plant has been designed on the separate-unit plan, and really consists of a number of distinct power plants side by side, each separate from the other, but each capable of assisting the other in case any part of the system should be disabled.

In addition to the generating system, a large storage battery plant will be installed.

The organization of the Baltimore Electric Power Company is as follows: president, D. E. Evans; treasurer, R. F. Bonsall; secretary, W. T. Spring. The present board of directors consists of H. W. Webb, D. E. Evans, John T. Stone, W. T. Burroughs, R. F. Bonsall, W. T. Spring and George R. Webb. The company has a capital stock of $3,500,000, and an authorized bond issue of $7,500,000. It is expected that the plant will be running by July, 1905.

The Williams Electric Clutch and Safety Device.

The Williams Electric Machine Company, Akron, Ohio, is manufacturing an electric clutch which is shown in the accompanying illustration. The driving principle of the clutch consists in the clamping together of a number of discs by magnetic action. The actuating coil is mounted concentric with the shaft of the clutch, and is enclosed in an oil and waterproof metallic case, which is, in turn, enclosed in the clutch proper, thus protecting it from damage from external sources. The coil is insulated to stand a breakdown test of 220 volts, alternating



ELECTRIC CLUTCH AND SAFETY DEVICE.

current, for 110 and 220-volt work, and 500 volts, alternating current, for 500-volt service.

The manufacturer states that the feature of residual magnetism, causing the clutch to hold for a short period after the current has been cut off, has been overcome, and that the clutch will take hold and let go promptly.

Two types of clutch are built—that in which the current is left on while the clutch is in operation, and that in which current is used only to throw the clutch on and off.

National Electric Light Association.

The National Electric Light Association has published the second edition of its report of rates for commercial lighting and power service. This publication is only for members of the National Electric Light Association, and is a confidential report.

The report on electrical methods of thawing water pipes, compiled by Mr. George S. Haley, of Rutland, Vt., has also been issued. This describes the methods of connecting up the electrical apparatus with the frozen pipes, and the experiences of a number of central-station men in making use of electric current for this service.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC SYSTEM IN EGYPT—An electric system is to be installed in the town of Tanta, Egypt. The contract has been awarded to Eugene Nahman & Company, of that place.

ELECTRICITY IN BARBADOES—There is a movement on foot in Barbadoes, W. I., to change the present system of horse-drawn cars to an electric line, and for an electric light plant to be operated by the traction company.

ELECTRIC RAILWAY IN ARGENTINE REPUBLIC—It is reported that a German syndicate has purchased the street car lines of Rosario, Argentine Republic, with the intention of changing the motive power from mules to electricity.

THIRD-RAIL POWER-HOUSE TO BE BUILT AT HARRISBURG, PA.—It is announced that the company which will build a third-rail road from the northern part of Pennsylvania through Harrisburg proposes to build a power-house in that city to cost $1,000,000. Another will be built at Sunbury.

POWER PLANT IN NEW MEXICO—A power plant is to be erected on the Pecos river, almost in the centre of the three cities of Las Vegas, Santa Fe and Albuquerque, and the electricity will be generated by water power. The company is capitalized at $500,000. It is the intention to begin work on the plant in a short time.

ELECTRIC RAILWAYS IN OHIO AND MICHIGAN MERGED—The Toledo & Northwestern Railway Company and the Ohio & Michigan Traction Company have consolidated and articles of incorporation of the consolidated companies were filed with the secretary of state at Lansing, Mich. The two companies have a capital stock of $1,500,000 jointly.

ELECTRIC LOCOMOTIVES FOR HEAVY GRADES—It is understood that the Norfolk & Western Railway proposes to use electric locomotives for pushing the heavy coal trains on the Elkhorn grade, Bluefield, W. Va. It has taken considerable power to get trains up this grade, and the inauguration of electricity for the purpose will mark a new era in railroading in Virginia.

TO FURNISH ELECTRICITY IN HARTFORD—H. B. Freeman, Jr., of Hartford, and twenty others have prepared a petition to the general assembly of Connecticut applying for a charter for a new electric plant which will furnish power and light in the counties of Hartford and Litchfield. It is planned to install the plant in the mills of the Cotton Duck Trust Company in New Hartford.

CONCESSION FOR ELECTRIC PLANT IN MEXICO—Carlos Navarro Mora has been granted a concession by the state government for the establishment of an electric light plant and nixtamal mill at the town of Chapala. The concession specifies that work on the two plants must be commenced within six months, and grants an exemption from all state taxes for a period of ten years. The plant will furnish light for the streets of Chapala.

MICHIGAN CENTRAL RAILWAY BUYS ELECTRIC LINES—It is rumored that the interurban line of the Jackson & Battle Creek Traction Company has been purchased by the Michigan Central Railway. The road between Kalamazoo and Battle Creek is also said to have been purchased. It is twenty-four miles long. The one between Battle Creek and Jackson is operated by the third-rail system and is one of the best electric roads in the country.

PLANS FOR MODERN LIGHTING PLANT IN PHILADELPHIA—The Commonwealth Electric Company, Philadelphia, Pa., proposes to spend at least $10,000,000 in the installation of a thoroughly modern electric lighting system in Philadelphia, providing the city council will grant a franchise. The company proposes to put in an underground system in the territory between Snyder avenue and Somerset street, and the Delaware river and Forty-second street. In addition to light, electric power will be furnished to the various manufactories in the city.

PROPOSITION TO MERGE WESTERN UNION AND POSTAL TELEGRAPH SYSTEMS—A report states that negotiations are pending for a merger of the Western Union and Postal Telegraph companies. It is said that suggestions have been made to both George J. Gould and his associates in the Western Union, and the Postal Telegraph management. If the Western Union acquires the Postal company a strong competitor will be removed and it will regain the handling of telegraph business along the Pennsylvania railroad, from whose lines its poles were removed about two years ago.

NORFOLK & SOUTHERN ROAD ACQUIRES ELECTRIC LINE—Deeds have been filed at Norfolk, Va., showing that the Norfolk & Southern Railroad has bought the Chesapeake Transit Company's broad-gauge electric line from Norfolk to Cape Henry. The deed provides for a $10,000,000 bond issue by the Norfolk & Southern, $4,000,000 only of which is to be issued immediately, the rest later for contemplated improvements at Cape Henry, for electrifying the Norfolk & Southern steam line to the Cape, for broadening the gauge of the Norfolk & Southern's Washington and Plymouth (N. C.) divisions and for extending the line south from Washington, N. C.

REORGANIZATION OF THE NEW MILFORD POWER COMPANY—It has been announced that the New Milford Power Company, the largest of its kind in Connecticut, and which furnishes power for trolley systems in Waterbury, New Britain and Bridgeport, and several smaller towns on the line of the Connecticut Railway and Lighting Company, has been reorganized. The new officers are: president, Winthrop G. Bushnell; vice-president, Louis E. Stoddard; secretary and treasurer, Samuel C. Morehouse. The company has an extensive plant in New Milford and an auxiliary plant is being built at Boardman's bridge. Offices will be established in New Haven.

NEWS NOTES FROM ITALY—The Italian ministry of posts and telegraphs has received authority from the parliament to establish telephonic communications between the following places: Brescia and Bergamo; Lecco and Bergamo, Cremona and Piacenza, Genoa, Pisa and Leghorn, Naples, Foggia and Barletta; Naples, Reggio, Calabra and Messina. The authorities of the province of Rome propose to build an electric railroad between the city of Rome and Civita Castellana. The city council of Venice has decided to purchase a number of electric launches for use on the canals of that city. The general inspector of the Adriatic railroad has received permission to purchase 150 electric accumulating batteries.

NEW INTERURBAN COMPANY IN INDIANA—An interurban company to connect many towns, with termini at Huntington, Ind., and Goshen, Ind., the line to be known as the Huntington, Columbia City & Nortwestern Railway Company, has filed articles of incorporation. It is possible that the proposed line will be continued at some future day to Union City. The capital stock of the company was placed at $25,000. The officers are: president, Benjamin Raupfer, Columbia City; vice-presidents, J. P. Dolan, of Syracuse, and W. A. Jones, of Huntington; secretary, W. H. Magley, Columbia City; treasurer, W. F. McLallen, Columbia City, and auditor, Melvin Blain, of Columbia City. The ultimate cost of the line was placed at $1,500,000.

TELEPHONE AND TELEGRAPH.

ALTA, IOWA—The Alta Telephone Company has been voted a twenty-year franchise.

LYNCHBURG, VA.—The Southern Bell Telephone Company has purchased the Lynchburg Telephone Company.

BLOUNTSVILLE, IND.—The Blountsville Telephone Company has sold its plant to the Cambridge City Company.

EDWARDSVILLE, ILL.—The Kinloch Telephone Company has completed the establishing of a new exchange in Edwardsville.

WILBUR, WASH.—Work has been commenced on a telephone line that, when completed, will connect Wilbur with Nespelem.

PROVIDENCE, R. I.—The New Riverpoint exchange of the Providence Telephone Company has been opened. It has a capacity of 800 lines.

BURLINGTON, VT.—The New England Telegraph and Telephone Company is completing a new line in South Burlington along the Hinesburgh stage route.

BOYNE, MICH.—The Independent Telephone Company of this place has been absorbed by the Bell Company. The price paid was in the neighborhood of $10,000.

WILMINGTON, N. C.—The Southern Bell Telephone Company will commence work at once on a modern exchange building at Greensboro. It will cost about $15,000.

HALLOWELL, ME.—Permission has been granted to the Woodland Telephone Company to place its poles in the town of West Gardiner, and the work will be speedily pushed to completion.

EUGENE, ORE.—Wires for the Eugene-Florence telephone line have been strung between Eugene and Elmira, a distance of fifteen miles. The remaining sixty-five miles will be strung as soon as the work of setting the poles is completed.

LA CANYADA, CAL.—The Home Telephone Company has completed line into the valley, and twenty-five 'phones are in service. The line was put out of order for a short while by a recent fire in La Crescenta, but was not badly disabled.

CRIPPLE CREEK, COLO.—The Colorado Telephone Company will spend approximately $50,000 in the Cripple Creek district—commencing shortly after the new year—in making improvements and installing practically a new telephone system here.

ST. PETER, MINN.—Stockholders of the Nicollet County Telephone and Telegraph Company have voted recently to purchase for $35,000 the St. Peter telephone system of James Bennett. The local system operates exchanges in St. Peter and Kasota and owns forty-three miles of lines.

HUNTSVILLE, ALA.—Another co-operative telephone company is being formed by Madison County farmers. The proposed system is planned to connect Wooley Springs, Jeff, Cluttsville and other communities in the northwestern part of the county with the Huntsville exchange.

DU BOIS, PA.—The Summerville Telephone Company is rebuilding its lines around Edgemont park, and is also stringing two additional sets of wires between DuBois and Falls Creek to take care of business from the connection which the Elk Telephone Company will have completed in a short time.

MILWAUKEE, WIS.—President Alonzo Burt, of the Wisconsin Telephone Company, states that as soon as the frost is out of the ground in the spring the company will begin building operations on its eight-story office building. The new building will cost between $150,000 and $200,000, and the equipment will cost an additional $150,000.

OTTAWA, KAS.—The toll line of the Home Telephone Company has been connected up with the central station of the Ottawa Telephone Company, opening up direct communication with Kansas City and all points in the Kaw valley over the independent systems. It is said that the workmen will go south into the oil fields as fast as the poles can be set and the wires strung.

ASHLAND, NEB.—The Ashland Telephone Company has been reorganized, the changes in the directory to take place January 1. H. H. Herndon, who owned a controlling interest, has sold his stock to H. A. and E. A. Wiggenhorn, Jr., and C. N. Folsom. The latter will succeed Herndon as president and general manager. Herndon will move to Hastings, where he is installing an independent system.

HUNTSVILLE, ALA.—The Southern Bell Telephone Company is making arrangements to install a new dry battery system of telephones in Huntsville at a cost of about $25,000. The company made an agreement with the city council to make this improvement, provided no other company is granted a franchise within a certain time. The new system will be ready for operation by April 1, 1905.

PITTSBURG, PA.—All the important difficulties in securing rights of way for the new Pittsburg & Allegheny telephone line to Wheeling, in connection with the national telephone system, have been settled satisfactorily and the line has been completed from Wheeling to Bridgeville. The work from Bridgeville to Pittsburg will be hurried and it is expected that the line will be in operation shortly.

MILWAUKEE, WIS.—The telegraph line between Milwaukee and Madison contemplated by the Postal Telegraph Company has been sanctioned by the officers and arrangements for the construction work will be made as soon as a decision is reached as to whether the line will be built during the present winter or not until spring. At present all messages between Milwaukee and Madison go *via* Chicago.

CHATTANOOGA, TENN.—The Southern Bell Telephone Company, with headquarters in Atlanta, is building lines to many of the towns in northern Alabama and Georgia. Within the past few weeks lines have been built to Fort Payne, Alexander City, Pell City, Jacksonville, Gadsden, Anniston, Center, Talledega and Trussville. This not only gives Atlanta connection with these towns, but Chattanooga also has a much better service.

CANTON, ILL.—Extensive improvements have been arranged for by which the patrons of the Canton Home Telephone Company will be able to talk directly to residents of Cuba, Farmington, Fairview, Lewistown, Avon, and nearly all the other towns throughout Fulton County, and with all farmers having connection with these towns. In addition to this, by connections with independent lines now operating throughout the state, communication will be possible over the company's wires to other cities. This extension of territory will mean that about 500 telephones throughout the county will be added to the company's list.

INTERNATIONAL FALLS, MINN.—The granting of a charter to the Rainy River International Telephone Company means that the towns along the Rainy river will have long-distance connection. The company has secured franchises from the towns of St. Frances, Emo and Rainy River, Ontario. A plant is soon to be installed here and connected with the three towns on the Canadian side of the river, as well as with the towns of Beaudette and Spooner, on the Minnesota side, which already have local systems in operation. In the spring a long-distance line—connecting the above towns—will be built along the Rainy river and extended into Winnipeg; and a little later on a line will be run from here to Northome, so that communication may be had with Minneapolis, St. Paul, Duluth and other points in the state.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company has recently made important additions to its service in Carroll County. The line from Westminster to Manchester has been extended to Alesia and Lineboro. In the western part of Carroll County new lines have been built from Union Bridge to Middleburg, Bruceville and Double Pipe Creek, thus extending the company's service all along the Frederick County line. The company has also been enlarging its plant in the southern part of Carroll County through the Sykesville exchange, and from there down into Baltimore County. Among the points covered by this addition are Morgan and Woodbine, in Carroll County, and Lisbon and Poplar Springs, across the line into Baltimore County. The company has further been building new lines in Harford County, and is now completing a line to Taylor and to High Point, in Harford County.

PERSONAL MENTION.

MR. J. M. OWEN, of Nashville, has been appointed local manager for the Cumberland Telephone and Telegraph Company to succeed Leon Allison.

MR. A. A. MILLER has been placed in charge of the new branch house of the North Electric Company, of Cleveland, Ohio, at Dallas, Tex. Mr. Miller has for some time been connected with the sales department of the same company at the Cleveland office.

MR. A. H. HAYWARD, general superintendent of the Dayton, Springfield & Urbana Traction Company, has been appointed general manager of the York City and York County (Pa.) Traction companies, to succeed Sheriff-elect S. M. Manifold, resigned. Mr. Manifold became general manager last spring. Immediately previous to that time he had been connected with the Western Maryland Railroad as superintendent of the local division.

MR. FRANK M. TAIT will assume the management of the Dayton (Ohio) Electric Light and Power Company, January 1, 1905. Mr. Tait recently resigned as manager of the New London (Ct.) Gas and Electric Company, and of the Oneco Manufacturing Company's machine shops in the same city. Mr. Tait reconstructed all departments of both companies during his connection in New London, and installed a good deal of new machinery. He has had unusual success in his previous appointments, and will no doubt bring to bear the same ability for a successful career in his new field.

MR. C. C. LEWIS, who for the last two years has occupied the position of chief engineer of the Schenectady Railway Company, will sever his connection with that company on January 1, 1905, when he will sail for London to enter the employ of J. G. White & Company, Limited. Mr. Lewis has been engaged principally to take charge of the work to be carried out by J. G. White & Company, Limited, at Montevideo, Uruguay. Mr. Lewis's experience in railway work has extended over fifteen years. He was connected with the Broadway cable work, and was afterward in Baltimore converting the lines of the Baltimore city railway from horse to cable. In Washington he was engaged on the electric conduit work of the Metropolitan lines, and in Buffalo as engineer of the International Railway Company. With the latter company he had charge of construction work involving the expenditure of between $3,000,000 and $4,000,000. In 1902 Mr. Lewis became chief engineer of the Schenectady Railway Company, having charge of the construction and maintenance of the tracks, buildings, overhead, and mechanical and electrical equipment. In addition he had charge of the rebuilding of the electric line between Schenectady and Albany, and the construction of the Troy & Ballston line, which has been equipped for the operation by both the direct-current and the new single-phase alternating-current systems.

MR. O. A. STRANAHAN has been appointed manager of the power department of the Allis-Chalmers Company, and will have charge of the sales of reciprocating engines, gas engines and steam turbines. Mr. Stranahan has been for the past three or four years in charge of the engine business of the British Westinghouse Electric and Manufacturing Company. He has given much attention to gas engine developments, particularly with regard to producer and blast-furnace gas, developments which are very much further advanced in Europe than in the United States. Mr. Stranahan graduated from Cornell in 1890, and immediately thereafter entered the service of Westinghouse, Church, Kerr & Company, and after working through its various departments, became chief engineer of its Chicago office. When the British Westinghouse Company was formed Mr. Stranahan was put in charge of its engine business. He began these duties in 1900. His new appointment dates from December 1. He arrived in New York, from England, about the middle of December, and proceeded at once to Milwaukee, where he will establish his headquarters.

MR. O. A. STRANAHAN.

ELECTRICAL SECURITIES.

For several weeks past financial interests have been considerably agitated over a campaign of publicity carried on by very prominent copper magnates. In an effort to smash one of the leading copper industrials valuable stocks have been forced to prices which were really lower than conditions called for. Within the last two weeks trading has reached the extremes of the 2,500,000-share mark and less than 500,000 per day. At the present time there is to be observed hardly any irregularity. There is little active dealing, and price changes are very slight. That there is a strong belief, however, in future betterments is very evident. There may not be any hope of an immediate resumption of an upward movement, but there is a widespread belief that the upward swing will ultimately continue. General trade and industrial conditions indicate that the progress is unabated, even though slow and conservative. Current estimates have placed the United States Steel Corporation's earnings for the December quarter at $18,730,000, about $4,000,000 over a year ago, and considerably in advance of what was anticipated a month ago. The market for steel rails has been active, and indications are in evidence that in railway construction alone a number of propositions which were abandoned a year ago are now being taken up with a sincere hope of carrying them to completion.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 17.

New York:	*Closing.*
Brooklyn Rapid Transit	59¾
Consolidated Gas	201½
General Electric	186
Interborough Rapid Transit	163
Kings County Electric	203
Manhattan Elevated	163¾
Metropolitan Street Railway	120¼
New York & New Jersey Telephone	165
Westinghouse Manufacturing Company	194½

The board of directors of the Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent upon the capital stock of the company, payable at the office of the treasurer on and after the sixteenth day of January next.

Boston:	*Closing.*
American Telephone and Telegraph	145½
Edison Electric Illuminating	252
Massachusetts Electric	60
New England Telephone	136
Western Telephone and Telegraph preferred	99

The annual report of the Massachusetts Electric Companies shows almost 2 per cent earned on the preferred stock. The surplus of the subsidiary companies over their fixed charges amounted to $438,716. Their fixed charges included interest on floating debt held by the Massachusetts Electric amounting to $105,181, making the total earnings for the Massachusetts Electric securities $543,897. After allowing for sundry expenses and interest on the coupon notes, the balance is $407,175, equal to not quite 2 per cent on the $20,557,400 preferred stock outstanding. The unfavorable weather conditions of last year affected gross earnings as well as operating expenses.

Philadelphia:	*Closing.*
Electric Company of America	10
Electric Storage Battery common	78½
Electric Storage Battery preferred	78½
Philadelphia Electric	10⅜
Philadelphia Rapid Transit	17¾
United Gas Improvement	105½

The directors of the United Gas Improvement Company have declared a quarterly dividend of 2 per cent ($1 per share), payable January 14, 1905, to stockholders at the close of business December 31, 1904.

Chicago:	*Closing.*
Chicago Telephone	145
Chicago Electric Light	170
Metropolitan Elevated preferred	65⅛
National Carbon common	43
National Carbon preferred	109
Union Traction common	12
Union Traction preferred	44½

ELECTRIC RAILWAYS.

BROOKLYN, N. Y.—The Brooklyn Rapid Transit Company will expend $250,000 in improvements to its Thirty-sixth street terminus.

SALT LAKE CITY, UTAH—The Utah Light and Railway Company has decided to spend $500,000 in improvements to its system.

WAUKESHA, WIS.—The Milwaukee Light, Heat and Traction Company has made preparations to continue the work of extending the Waukesha Beach line to Oconomowoc in the near future.

SPRINGFIELD, ILL.—The city council has passed an ordinance allowing the Consolidated Street Railway Company to make the track extensions requested.

UXBRIDGE, MASS.—The contract for the extension of the Uxbridge & Blackstone Electric Railroad has been awarded to W. H. Taylor & Company, of Worcester.

NORWICH, CONN.—The contract for the construction of the East Lyme Street Railway has finally been awarded. It is hoped to have the road in working order by June 1.

DURHAM, N. C.—The county commissioners have granted the franchise asked for by the Raleigh & Durham Passenger and Power Company. The road, it is understood, will touch at Cary and Morrisville.

VOLUNTOWN, CT.—A project is on foot to build an electric line from this town to either Norwich or Jewett City, utilizing the rights under an old charter which would permit a line to Jewett City.

SIOUX CITY, IOWA—R. H. Burton-Smith is in charge of arrangements for a proposed interurban line starting from this city. The details are lacking as to the direction and extent of the line proposed.

TOLEDO, OHIO—A La Porte (Ind.) dispatch announces that the proposed Toledo-Kendallville, Ind., electric line will be financed about January 1. It is to be an extension of the Toledo & Western railway system.

ENSLEY, ALA.—A franchise has been granted the Birmingham Railway, Light and Power Company by the mayor and aldermen of Ensley to build a double track from the end of the Tuxedo line to Sherman Heights.

WELLSVILLE, OHIO—W. L. Smith has asked the council for a franchise for a new street railway through the city. The Ohio river will be bridged to Congo, W. Va., making a direct line to East Liverpool, Ohio.

EVERETT, WASH.—The county commissioners have granted a franchise to W. M. Snyder and J. W. Hall, of Snohomish, for the construction of an electric road from Monroe through the Sultan basin to the "45" mine.

ALBANY, N. Y.—The South Shore Traction Company, which is to operate a road along the Long Island shore from Jamaica to Patchogue and Brook Haven, has been granted permission to use the overhead trolley system.

MOUNT VERNON, N. Y.—The Union Trolley Company is contemplating the extension of the trolley along the Pelham road from the intersection of Fort Schuyler to Pelham Park. Work is expected to commence in the spring.

SOUTH SOLON, OHIO—The village council of South Solon has passed the ordinance granting a franchise to the Springfield, Charleston, Washington & Chillicothe Traction Company to operate a traction line through the village.

NAHANT, MASS.—The Nahant selectmen have tendered the franchise for a trolley road from Nahant to Lynn to Walter S. Southwick. Mr. Southwick has accepted the franchise and will begin the construction of the road at once.

DENVER, COL.—At an expenditure of $100,000 the Colorado Midland is planning to electrify twenty miles of its line in the Pike's Peak region. The proposition is to electrify the line in Ute pass between Colorado Springs and Woodland park.

STILLWATER, MINN.—The board of county commissioners of Washington County has granted the Minneapolis, St. Paul & Suburban Railway Company the right to build the proposed South Stillwater extension through the towns of Stillwater and Baytown.

WINDSOR, ONTARIO—The Windsor council has been asked to transfer the Windsor franchise of the Ontario Traction Company to the Windsor & Tecumseh Electric Railway Company, as the latter has powers to build a line from Walkerville to Tecumseh.

AUSTIN, TEX.—The Houston-Galveston Interurban Railroad Company has increased its capital stock from $1,000,000 to $2,000,000. This company claims to have all plans arranged of an electric railway between Houston and Galveston, a distance of fifty miles.

MILWAUKEE, WIS.—The Chicago, Kenosha & Milwaukee Railway Company has purchased three and a half miles of right of way directly south of Kenosha for $8,800. This is the last link in the right of way for an electric railway between Milwaukee and Chicago.

MARSHALL, MICH.—Charles E. Sawyer, of this city, George A. Hoeltzel, of Battle Creek, and Earle B. Hughes, of Valparaiso, Ind., are officers of the Michigan & Indiana Traction Company, capital $750,000, which is to build an electric line from Battle Creek to Lansing.

ALBANY, N. Y.—The Syracuse, Skaneateles & Moravia Electric road to-day has been granted the commission's approval of the issue of a mortgage for $1,500,000 on condition that but $500,000 shall be issued without first making further application to the commission for authority.

SPOKANE, WASH.—The Washington Water Power Company is planning on building a branch line to Silver Lake in connection with the Medical Lake system. The company has secured from the Medical Lake council a franchise to run east on Lake avenue for a Silver Lake line.

FORT WAYNE, IND.—The Toledo and Western electric line, now in operation between Toledo and Pioneer, Ohio, may be extended to Angola next year. If the Bucklen line from Elkhart to Lagrange should be extended to Angola, the latter town would have a through line east and west.

NILES, MICH.—F. Marion Gray, local capitalist, has started a movement to form a company and build an electric line west from Buchanan, through Dayton, Three Oaks and New Buffalo to Michigan City, Ind. The Niles & Buchanan Railway Company is about to build a line from Niles to Buchanan.

MINNEAPOLIS, MINN.—Indiana capitalists in cooperation with the Twin City Rapid Transit Company, will build a trolley line from St. Paul and Minneapolis to Faribault, Minn., to do a passenger and light freight business. The line will traverse a thickly settled territory for forty miles.

PRINCETON, IND.—The Pocket Electric Railway Company recently organized here, has announced its intentions of constructing a line from this city to Petersburg, Ind. Actual work of grading the road is to begin in the spring. A large part of the right of way for the line has already been secured.

PITTSBURG, PA.—The Marshall Avenue Railway Company and the Watson Street Railway Company have secured charters in Harrisburg, both being for the operation of a continuous line of electric cars in Pittsburg and Allegheny. The charters are asked through William Kauffman, who is the president of the companies.

COLUMBUS, IND.—There are still prospects of an electric line from this city to French Lick. This road has been proposed for over a year, but plans of different promoters miscarried. Now the men originally interested in the idea of building a road are again at work, and say that something definite will be done by spring.

TROY, N. Y.—There are good prospects of another important electric line being constructed between Albany and the east through Rensselear County, under an old charter granted over thirty-one years ago to the Boston, Hoosac Tunnel & Albany Railroad Company, incorporated by the late John Swinburne, William J. Paddock, Castle W. Herrick, J. Thomas Davis, David Phillips, William J. Weaver, Edward Brennan, Thomas McCarthy, C. Adams Stevens, C. Goodard, James C. Moore, James N. Ring and James Hyde

Pratt. The old charter calls for a railroad from the village of Hancock, Mass., to Albany city.

SHENANDOAH, PA.—An electric railway line between Shenandoah and Pottsville *via* Frackville is planned by Schuylkill County capitalists. The right of way through Frackville and intermediate boroughs has been asked for by William H. Wilhelm, George E. Gorber and W. J. Smith, the latter superintendent of the Schuylkill Traction Company.

CLEVELAND, OHIO—The Cleveland Electric Railway Company is to equip all of its double-truck cars with air brakes at an estimated expense of $150,000. The company is also considering placing an order for fifty new convertible cars. A contract has been let for the building of a storage-battery station at the Newburg end of the system.

WARREN, R. I.—Business men in Warren would like to see an electric road built from Warren to Brimfield, Wales and Stafford Springs, Ct., and they are confident that a line opening up this section of the country would be a paying investment, beside making Warren a centre for electric roads. A road to these towns has been talked of several years.

SHARON, PA.—The burgess of Wheatland has signed the ordinance giving the Sharon-Wheatland Street Railway a franchise through the town. As the company has already obtained the right of way to West Middlesex the five miles of road will be completed by next summer. From West Middlesex the line will probably be extended to Pulaski and other places.

CLEVELAND, OHIO—An agreement to reorganize the Wasnington, Berwyn, & Laurel Electric Railroad Company has been reached and the reorganization committee, composed of E. G. Tillotson, W. N. Gates, W. S. Hayden and L. J. Wolf, has requested the bondholders to deposit their holdings with the Cleveland Trust Company, preliminary to carrying out the agreement.

POTTSTOWN, PA.—The council has granted permission to the Trappe & Limerick Railway Company to lay tracks on Queen, Adams and King streets. The ordinance provides for the payment of $16,000 and the paving, for a width of nine feet, of the streets occupied. The road, which is an extension of the Schuylkill Valley line from Sanatoga to Pottstown, is now being built.

DENVER, COL.—It is announced that the Denver City Tramway is to extend its line from Englewood to Littleton. The franchise was granted over a year ago to William Stearns, of Littleton, and negotiations have been under way for some time, looking to the securing of the franchise by the tramway officials. There is a choice of several routes and the exact one has not yet been decided upon.

HARRISBURG, PA.—The Lackawanna, Wyoming Valley & Western Railroad has applied to Governor Pennypacker for a charter. The road now runs from Carbondale to Wilkesbarre by way of Scranton. The charter for which application has been made will allow it to be extended twenty miles, and it is proposed to eventually bring it through Sunbury and Harrisburg to Washington, D. C.

CUMBERLAND, MD.—It is rumored that the Cumberland & Pennsylvania Railroad has under consideration a trolley line over the Eckhart branch from Cumberland and extending to Frostburg. The Eckhart branch ends at Eckhart, and it would be necessary to build only a mile and a half over the company's own property to reach Frostburg. The Eckhart branch is a coal road, hauling about 2,000 tons a day.

BUFFALO, N. Y.—It is announced that the Oneida Railway Company will next spring begin the work of the electrification of the section of the West Shore railroad which is located in the central part of New York state. One purpose of the contemplated improvements is to establish a better local traffic service between towns in that part of the state, thus relieving the railroad's hauling facilities and creating new business.

PALO ALTO, CAL.—It has been announced that the syndicate which is promoting the construction of the Palo Alto and San Jose electric road has purchased the Santa Clara & San Jose electric road and also the line from San Jose to Alum Rock Park. The syndicate intends to extend the line from Santa Clara north through Palo Alto to San Mateo, and if satisfactory connections can not be made with the San Mateo line a separate road may be built from there to San Francisco. The surveys have been made and most of the right of way secured.

WASHINGTON, PA.—Pittsburg and Wheeling capitalists are back of a project to build a trolley line from Wheeling to Uniontown, and will connect at the latter place with their "coke region" trolley system into Pittsburg. Preliminary surveys are being made. From Uniontown the route is through Millsboro, Washington County, up Ten Mile creek and Short creek and through Sparta, Old Concord and Enon, in Greene County, to Wheeling creek.

LITTLE ROCK, ARK.—S. J. Norman, secretary and treasurer of the North Arkansas Electric Railroad and Power Company, reports that the length of the road will be increased from fifty to 132 miles and the capital stock from $150,000 to $500,000. The company has graded eighteen miles through Searcy and Newton counties, east from Mount Hersey, and has surveyed about sixty-five miles. The terminus of the line is not announced.

SHARON, PA.—A Pennsylvania state charter has been issued to the street railway company, with a nominal capital of $20,000. The incorporators are John W. Parker, New York; Curtis G. Hussey, Allegheny; Hobart M. Adams, Cleveland; Marcella C. Adams and Thomas N. Guffy, Pittsburg. The company will build a street car line from Meadville to New Castle, which will be a feeder for the road to Erie, Jamestown and Buffalo, N. Y.

RALEIGH, N. C.—The Raleigh-Durham Passenger and Power Company has been chartered for the purpose of constructing an electric railroad between Raleigh and Durham, two belt lines in Raleigh, power and light plants for the two cities and an ice plant for Durham. The capital stock will be $125,000. Surveys for lines are to begin as soon as the franchise is secured. W. J. Nellms is one of the principal incorporators. Other incorporators are T. B. Fuller, B. S. Jerman and Jones Fuller.

LOUISVILLE, KY.—The Louisville & Southern Indiana Traction Company has commenced the reconstruction of the Highland electric line, which it recently purchased from the Highland Railway Company at New Albany. The line will be connected with the New Albany street railway lines, which are operated by the traction company, in connection with the line between New Albany and Jeffersonville. The latter is being extended over the Big Four bridge at Jeffersonville to Louisville.

MEMPHIS, TENN.—Options are being secured for an electric railway between Paducah, Ky., and Cairo, Ill. The distance is about thirty-five miles and the estimated cost of the road is $800,000. Arrangements have been made for the construction and equipment of the line, and it is expected that the road will be in operation within a year. The line will be used for both freight and passenger business. The line will run to East Cairo and will reach Cairo proper by means of a transfer boat system.

OBITUARY NOTICES.

MR. FREDERICK GOTTFRIED, vice-president of Patterson, Gottfried & Hunter, Limited, New York city, died at his home at Upper Montclair, N. J., on Wednesday, December 7. Mr. Gottfried was one of the founders of the firm.

EDWIN D. McCRACKEN died at his home, Leonia, N. J., on December 13. Mr. McCracken was engaged in electrical work all his life, the last and most important of his discoveries being the use of paper as insulation for underground cables. For this he received the medal of honor from the Franklin Institute, of Philadelphia.

PAUL D. CONNOR died at his residence in Washington, D. C., on December 12. He is reputed to have been one of the oldest telegraph constructors in the country, and to have taken an active part in the early development of the telegraph, assisting Professor S. F. B. Morse in the construction of the first line from Washington to Baltimore. He held responsible positions at various times with the Western Union Telegraph Company, and with the Southern Telegraph Company.

NEW INCORPORATIONS.

SAN FRANCISCO, CAL.—Lake County Light and Power Company. $25,000.

ST. PAUL, MINN.—Patterson Street Lighting Company. Increased from $50,000 to $150,000.

MADISON, WIS.—Alma Electric Light Company. $5,000. Incorporators: John Harry, Russell N. Smith and Frank Harry.

GADSDEN, ALA.—Etowah Light and Water-power Company. $24,000. Incorporators: A. L. Dupre, J. P. Brown and A. Brown.

JEFFERSON CITY, MO.—Spring River Power Company of Kansas. $450,000, of which $50,000 is to be employed in Missouri.

OZARK, ARK.—The Western Telephone Company. $100,000. Incorporators: J. F. Massey, Will Hill, John E. Bryan and L. R. A. Wallace.

MATTHEWS, IND.—Matthews Electric Light and Power Company. $15,000. Directors: Philip Hughes, G. S. Renebolt and Everett W. Trook.

RUSSELLVILLE, ARK.—Merchants' Light and Cold Storage Company. $50,000. Incorporators: A. Bernard, S. J. Smallwood, R. J. Harkey and W. T. Meek.

WASHINGTON, D. C.—Red Cloud Electric Light and Mining Company. $300,000. Incorporators: George H. Corey, Eugene Schooley and J. L. Cohencious.

CHARLESTON, S. C.—Charleston & Summerville Electric Railway Company. $1,000,000. Incorporators: R. J. Smith, E. P. Guerard and others, of Summerville.

EAST LIVERPOOL, OHIO—Newell Street Railway Company. $10,000. Incorporators: Walter B. Hill, Joseph G. Lee, W. E. Wells, Edwin M. Knowles and H. N. Harker.

NEW YORK, N. Y.—Northern Westchester Light and Power Company. $5,000. Directors: R. S. Hull, Brooklyn; A. S. Andrews, Flushing, and John Larkin, New York.

MACKINAW, ILL.—Mackinaw Electric Light Company. Operate light, heat, water and power plants. $8,000. Incorporators: S. A. Thompson, George Tyrrell and C. G. Sparks.

BELLEVILLE, ILL.—Ada Electric and Gas Company. Furnish light, heat and power and manufacturing ice. $100,000. Incorporators: J. A. Hamilton, A. B. Daab and L. D. Turner, Jr.

HARRISVILLE, N. Y.—Harrisville Electric Light and Power Company, to manufacture electricity, $10,000. Incorporators: Joseph Weekes, Sr., J. E. Harney, Don F. Sprague, Harrisville, N. Y.

HASKELL, I. T.—The Haskell Telephone Company. $10,000. Incorporators: J. C. Scully, C. E. Henson and W. J. Criswell, of Haskell, I. T., and Earl G. Hopkins and George S. Whidden, of Boynton, I. T.

HARRISBURG, PA.—Plain Grove Telephone Company, of Plain Grove Township; to build a telephone line in Lawrence and Mercer counties. $5,000. Directors: W. D. Maxwell, G. E. Montgomery, W. B. Rodgers and others.

HARRISBURG, PA.—Bridgeville Street Railway Company, ten miles long, in Scott Township, Allegheny County. $60,000. President, A. J. Barron, Pittsburg. Marshall Avenue Street Railway Company, six miles, from Allegheny to Brighton Road to a proposed bridge across the Allegheny river to Pittsburg. $36,000. President, William Kaufmann, Allegheny. Huntingdon Street Railway Company, of Huntingdon, the lines of which will run from Huntingdon to Smithfield, Petersburg, Alexandria, Alfa Ranta and Mt. Union, thirty miles. $180,000. President, Elmer E. Davis, Johnstown. Greenville Street Railway Company, four and one-half miles. Through the streets of Greenville. $26,000. President, Curtis G. Hussey, Allegheny. Watson Street Railway Company, Allegheny. One and one-half miles. $9,000. President, William Kaufmann, Allegheny.

NEW PUBLICATION.

ENGINEERS OF AMERICA—A directory and biography of the engineers of America is being prepared by Mr. Ernest C. Brown, editor of the *Progressive Age*, New York city. The need of a terse biographical directory of engineers who have established reputations has long been recognized, but the difficulties of compiling such a work have heretofore prevented its being undertaken. The proposed volume will be an octavo, 6 by 9 inches, containing 700 pages, embracing brief biographies of about 3,000 prominent engineers belonging to the civil, electrical, mechanical, mining and chemical engineering societies. As the total membership of all these societies is about 10,000 it will be impossible to include biographies of all of these, therefore the publisher has decided to incorporate only the names of gentlemen who have been active members in the organizations named for the last ten years. When this rule is not strictly adhered to it will be in the cases of men who have attained distinction in their professions, and who have not been affiliated with the society in their particular sphere of activity for that period of time. The publisher is now sending out a circular letter to those engineers whose biographies are desired. It is the intention to give in the work the names and life work of only those men who have made a career for themselves.

ENGINEERING SOCIETIES.

THE AMERICAN ELECTROCHEMICAL SOCIETY—At a meeting of the board of directors held at the office of the society November 5 the following applicants were elected to membership: Francis X. Govers, Oswego, N. Y.; Y. Shingo, Tokio, Japan; J. Sigfrid, Edstrom, Vesteras, Sweden; Herman Schlundt, Columbia, Mo.; George G. Grower, Ansonia, Ct.; E. H. Seaman, Wantagh, Long Island, N. Y.; Birger Carlson, Manssbo, Avesta, Sweden; Professor Ralph E. Myers, State College, Pa.; William Koehler, Cleveland, Ohio; Arthur Burwell, Lakewood, Ohio. The annual meeting of the society will be held at Boston and Cambridge, Mass., April 25, 26 and 27, 1905. The Hotel Lenox, Boylston and Exeter streets, Boston, will be the headquarters of the society. An interesting programme is being arranged by the local committee of which Dr. W. H. Walker is chairman.

TORONTO BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The eleventh regular meeting of the Toronto branch of the American Institute of Electrical Engineers was held on Friday, November 18. Professor T. R. Rosebrugh, of the School of Practical Science, introduced the subject for discussion, which was "Single-phase Railway Motors." He reviewed briefly the various papers on the subject which have appeared in the transactions of the Institute since the first application of this type of motor for railway purposes, and stated that the question of frequency was a very important factor; while high frequencies were first used, the present tendency is to adopt a frequency of twenty-five cycles. This is considered necessary in order to avoid sparking, and Professor Rosebrugh thought it quite possible that a frequency as low as fifteen would be adopted in the near future for railway work. At the regular meeting of the Toronto branch on Friday evening, December 9, the discussion on "Construction Work" was introduced by Mr. C. H. Wright.

WORCESTER POLYTECHNIC INSTITUTE BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On the evening of December 9, Mr. A. H. Armstrong, of the railway engineering department of the General Electric Company, Schenectady, N. Y., gave an illustrated lecture on "Alternating-Current Railway Motors" before the Worcester Polytechnic Institute branch of the American Institute of Electrical Engineers. The lecture dealt with the development of this type of motor during the last few years. Many views were shown of the past and present forms of motors used in the best railway practice. In considering the future of railway motors Mr. Armstrong gave as his opinion that the direct-current motor would take the lead where heavy tractive effort was required, as in locomotive work; but that, in light work—for trolley cars, etc.—the single-phase alternating-current motor would undoubtedly be most prominent. One great advantage of this latter motor is its ability to run practically as well with direct current as with alternating current. The next meeting of the branch will be held on the evening of January 6, 1905. At this time there will be a discussion of Institute papers. Mr. Charles H. Gilbert is secretary of the Worcester Polytechnic Institute branch.

ELECTRIC LIGHTING.

MARION, IND.—About 200 new arc lamps are to be installed by the city.

CHESTER, PA.—The Upland borough council has accepted the bid of the Beacon Light Company.

DALLAS, ORE.—A 150-horse-power engine will be installed in the Dallas Electric Light Company's plant, replacing the present one of eighty horse-power.

GREY EAGLE, MINN.—At a recent meeting of the village council Guy Robbins was granted an electric light franchise. Work will be begun in the spring.

EMPORIA, KAS.—The city will invest the $10,000 that remains from the appropriation made to rebuild the electric plant two years ago for further improvements.

LANCASTER, N. H.—The power plant of the Lyman Falls Power Company on the Connecticut, two and one-half miles above North Stratford, is finished and connection with the substation at Groveton has been effected.

SOUTH BETHLEHEM, PA.—W. W. McKee, receiver of the Lehigh-Northampton Gas and Electric Company, has been authorized by the court to issue certificates to the amount of $65,000, with which to increase the capacity of the plants.

GEORGETOWN, CAL.—The following are the directors of the recently incorporated Loon Lake Water and Power Company: Stanley Forges, Cleaveland Forbes, Warren Gregory and W. H. Chickering, of San Francisco, and C. M. Fitzgerald, of Georgetown.

NORTH TONAWANDA, N. Y.—The Home Electric Light and Power Company has petitioned the board of aldermen for a franchise to erect, string and maintain the necessary cables, wires, etc., for the distribution of electricity for lighting and power purposes. It will use the poles of the Niagara County Home Telephone Company.

FAIRFIELD, IOWA—The Fairfield city council has entered into a contract with the Western Electric Company, of Chicago, for a new lighting plant to be installed in this city as soon after the first of the year as possible. There will be seventy-five lamps, each 2,000 candle-power. The dynamo of the present lighting plant will carry fifty lamps, so that there will be at least one hundred and twenty-five lamps. The price of the new plant will be $2,735.

TRENTON, N. J.—The vice-chancellor has made an order permitting Receiver Richard Stockton to sell at public auction the property of the Frechold Electric Light, Heat and Power Company. The receiver is ordered to give four weeks' notice of the sale. The petitioner shows that he can not operate the plant as at present constructed and pay for the operating expenses. The company is bonded for $10,000.

NEW MILFORD, CONN.—There is a revival of the report that the Connecticut Light and Power Company is seeking to obtain control of the water rights at Bull's bridge now controlled by the New Milford Power Company. In the summer it was understood that the Connecticut company had plans to establish a secondary plant at Boardman for the generation of electricity which was to supplement the Bull's bridge plant.

CHAMBERSBURG, PA.—The borough council has accepted the bid of Charles Walter, representing the Chambersburg Light, Heat and Power Company, at $75,550, for the electric light plant, which the borough has owned and operated at a loss for fifteen years. The company entered into a contract to light the streets of the town at $74.50 a year for each arc light, and also named prices for municipal and commercial lighting. An ordinance was adopted ratifying the sale.

NEWARK, N. J.—The question of the municipal ownership of a lighting plant has been definitely disposed of by the Irvington town council. A contract was made recently with the United Electric Company for a period of five years at a rate of $15 per lamp per year for a thirty-candle-power light. A concession was made by the company in the shape of an agreement to light the town hall and public schools free. At present the town is paying $16 per lamp on a one-year contract. The United Electric Company was the only bidder.

JACKSON, MICH.—A big power dam project is under way to furnish power for electric lighting for Whitehall and Montague and other purposes. R. H. Updyke, a civil engineer from Grand Rapids, has been working for the last two years on a plan and has the details nearly completed for the damming of White river and the construction of a large power-house on the dam. A forty-foot head of water will be maintained and in the power-house will be large dynamos which will generate enough power to transmit current for electric lighting, pumping and for electric cars as far as Grand Rapids.

GOLDFIELD, NEV.—A project is under way to supply this camp and Tonopah with electric lights and power from Bishop creek, Inyo County, California, and the probabilities are that the work on the great undertaking will begin within a few weeks. Denver and Goldfield parties are behind the scheme, which involves the expenditure of nearly a half million dollars and the running of feed wires from Bishop to Goldfield and Tonopah, a distance of eighty miles, directly across the White mountains. Already water rights have been secured on Bishop creek and surveys for the plant and the wire lines have been made.

AUTOMOBILE NOTES.

ANNUAL BANQUET OF THE AUTOMOBILE CLUB OF AMERICA—The annual banquet of the Automobile Club of America will take place at the Waldorf-Astoria, New York city, on the last evening of the Automobile Show, January 21, 1905. The grand ballroom and the Astor gallery will be decorated in a unique manner. The speakers will include Senator John H. Mitchell, of Portland, Ore.; the Hon. Charles F. Warwick, Philadelphia, Pa.; P. F. Murphy, former president of the club; Winthrop E. Scarritt, Samuel W. Taylor, William Phelps Eno, William H. Page, Jr., and others. The president, Mr. Dave H. Morris, will preside. The dinner will begin promptly at eight o'clock and will end at eleven.

NEW CLUB-HOUSE FOR THE AUTOMOBILE CLUB OF AMERICA—At a recent meeting of the board of governors of the Automobile Club of America the committee on new building presented a report recommending that the club erect a club-house and garage of its own. This report was accepted and adopted, and the committee discharged. The president was empowered to appoint a committee of three to prepare plans for financing and erecting a club-house and garage, such plans to be submitted to a special meeting of the club to be called for that purpose. In accordance with the positive stand which the Automobile Club of America has taken in the matter of reckless driving on the highways, a reward of $100 is offered for information resulting in the arrest and conviction of the person or persons in an automobile who ran into and wrecked the wagon of Jacob Clemons, on the Pelham Parkway, on the night of November 16, 1904.

NEW COMPANIES.

BOSTON, MASS.—Frank P. Blake, of Boston, is president, and Hugh A. Quinn, of Woburn, treasurer, of the Blake Electric Company, incorporated with a capital of $10,000.

PORTLAND, ME.—The National Electrical Construction Company has been incorporated with a capital of $500,000. M. W. Baldwin is president and G. C. Knight, treasurer.

WASHINGTON, D. C.—The Safety Electric Railway Construction Company has been incorporated with a capital of $1,000,000. The incorporators are Andrew H. Angle, Abraham Garbeil, G. Van Casteel, Rankin Mason and W. W. Fentress.

CHICAGO, ILL.—The R. V. Wagner Company has been incorporated to manufacture electric medical instruments. The company has a capital of $30,000, and the following are the incorporators: Henry B. Husted, Helf B. Husted and Thurman T. Wagner.

NEWARK, N. J.—The H. O. S. Engineering Company has been incorporated with a capital stock of $25,000, by Ferdinand S. Crosley, Gilbert W. Roberts and Oscar Weis. The company is to manufacture and deal in motors, dynamos and all kinds of electrical machinery.

INDUSTRIAL ITEMS.

EUGENE MUNSELL & COMPANY, 218 Water street, New York city, and 117 Lake street, Chicago, is distributing a new catalogue descriptive of mica for electrical purposes. The company is prepared to deliver mica cut and uncut, stamped solid sheet segments, washers, rheostats, etc. Samples and quotations will be furnished upon application.

THE GEORGE F. WESCOTT COMPANY, Buffalo, N. Y., has bought the entire rights, plant, etc., of the Power Installation Company, and will continue the business of designing, manufacturing and installing of power plants, factory equipments and labor-saving machinery, taking charge January 1. The company is also building large new shops in Buffalo.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, will be pleased to send upon request its elaborate catalogue descriptive and illustrative of pulverizing machinery. The Jeffrey company is the sole manufacturer of Schœllhorn-Albrecht patented pulverizing machinery. This catalogue describes pulverizing machinery for various industries.

THE CRESCENT COMPANY, 203 Broadway, New York city, and Omaha Building, Chicago, is distributing a bulletin descriptive of Crescent coloring fluid and Crescent lamp frosting. This fluid is put up in various colors in half-pint, pint, quart, half-gallon and gallon bottles. The Crescent Company also handles a large line of specialties for electrical construction.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., in catalogue No. 12 describes and illustrates electrical measuring instruments. This book contains a great deal of information which is of value to every electrical engineer. Not only are the instruments described in their commercial application, but the theory is carefully detailed, leading to a better understanding of the principles of operation.

THE WESTINGHOUSE MACHINE COMPANY, Pittsburg, Pa., has published a handsome catalogue descriptive of mechanical stokers. This catalogue illustrates and describes the Roney mechanical stoker. Typical installations are shown, and the operation and construction of the Roney stoker are taken up in detail. In addition to the mechanical stoker, there is described the Roney triple-roll coal crusher. A number of splendid half-tone views give a good idea of the adaptation of Roney stokers to large boiler plants.

JOHN WILEY & SONS, 43-45 East Nineteenth street, New York city, will be pleased to send its complete catalogue of text-books and industrial works for schools, colleges, polytechnic institutes, engineers, architects, chemists, military and naval officers. This catalogue lists a great variety of selected books dealing with subjects from agriculture to sanitary science. The description of each book is very complete, giving the title of the work, the author, and a sketch of the contents. A carefully compiled index makes it easy to secure information under any classification. This company issues a number of special pamphlets bearing on different classifications of literature. A specially valuable series of opportunities is now being presented for the holiday market.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, in bulletin No. 24 describes type K magneto telephones. All the working parts of this telephone are in standard interchangeable form. The woodwork can be furnished in either oak or walnut. In bulletin No. 25 the company calls attention to the North permanently adjusted receiver. The feature in the North receiver lies principally in the construction and arrangement of the posts, which render adjustment independent of the cell. This is accomplished by providing a solid metal cup, upon which all parts are mounted, including the diaphragm. The working parts and mounting being of the same metal and having practically the same coefficient of expansion the temperature variation can not have any deleterious effect. The company has established a branch house at Dallas, Tex. It was opened for business on December 15.

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD COMPANY has issued No. 36 of the "Four Track" series, entitled "The Winter Boarder." This pamphlet gives a lot of information on this subject, and is for the instruction of all intending travelers. The pamphlet gives a list of more than 1,000 hotels and boarding-houses in all parts of the country, together with the name and address of the proprietor, the number of people the house can accommodate, and its rates per day and per week. The booklet covers the country quite generally from New York to the Pacific coast, including the Adirondack mountains, Canada, Colorado, Utah, Arizona, New Mexico, Texas, California, Washington and Oregon, including also the Hawaiian Islands. Copies of this booklet will be sent free, post paid, to any address on receipt of a two-cent stamp, by George H. Daniels, general passenger agent, Grand Central station, New York city.

THE WILLIAMS ELECTRIC MACHINE COMPANY, Akron, Ohio, has entered the electrical manufacturing field. This company is financed by some of the best and strongest financial interests of Akron, and is placing on the market a full line of electric clutches and electric stopping or safety devices, to be used in stopping machinery in case of accident to the operator. These clutches are the invention of Mr. H. A. Williams, who is the general manager of the company. The concern is also placing on the market a full line of electrical apparatus, both alternating current and direct current, including motors, generators, switchboards and controllers. The company will also undertake the installation of complete transmission plants, embracing clutches, safety devices, generators, engines, motors, switchboards, line shafting, hangers, pulleys, etc. Catalogue A, which the company has recently issued, describes the combined electric clutch and safety device.

THE SOUTHERN RAILWAY, WASHINGTON, D. C., is carrying on a valuable campaign of literature aimed at bringing into publicity the exceptional opportunities for investing and settling in the country tributary to its lines. In the territory of the Southern Railway, the Mobile & Ohio Railroad and the minor associated lines, comprising some 8,600 miles of road, there has been invested in the several classes of development during the past three years the immense sum of $340,000,000. The land and industrial department of the Southern Railway, under the direction of Mr. M. V. Richards, land and industrial agent, publishes a very interesting magazine entitled "The Southern Field." In the November issue of this paper the plant of the Alabama Iron and Steel Company at Gadsden, Ala., is described and illustrated. In addition to this there are numerous articles of special interest to the business men of the community and to those who are looking for the opportunity of securing high-class industrial sites. The Southern Railway penetrates the states of Virginia, Georgia, Tennessee, North Carolina, Florida, Mississippi, South Carolina, Alabama, Kentucky, Indiana and Illinois. Mr. C. H. Ackert is the general manager at Washington, D. C., Mr. S. H. Hardwick is passenger traffic manager at Washington, D. C., and Mr. William H. Tayloe is general passenger agent, Washington, D. C.

THE KUSEL & KUSEL AUTOMATIC SWITCHBOARD AND TELEPHONE MANUFACTURING COMPANY, 617 Monadnock Block, Chicago, Ill., has entered the field of manufacturing apparatus for independent telephone companies. This company will be known as the Kusel & Kusel Company, and will have its main offices and salesrooms in Chicago. Messrs. Kusel are two of the best known telephone men in the independent field. They have covered practically every district in the country where independent telephony has been established. The line of apparatus this company is placing on the market comprises a complete equipment of telephone supplies. A specialty which the company is calling attention to is the "K K" magnetic, "Ring Thru" coil and "Ring Thru" telephones. This is a special device which is designed to obviate the use of condensers, choke coils, carbon-resistance coils and non-inductive coils, for the purpose of enabling subscribers on party lines or bridged lines to ring through with the receivers off the hooks. As an incentive to secure initial orders, the company is prepared to deliver to all new customers an "Auto" clock, which it states is of unique and handsome design. The company has now in press a revised edition of "Independent Telephone Practice," by I. J. Kusel and A. E. Dobbs. Copies of this will be distributed throughout the independent field. The company is introducing a new dry battery for telephone work, which it claims will give from fifteen to twenty amperes under long and severe conditions of service. This is designated as the "Eagle" dry battery. The loose-leaf bulletin for 1905 will be sent to any one interested upon request.